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The interrelationships among nutritional status, living environment, and school performance of first through third grade primary school children living in low socioeconomic areas in Khartoum, Sudan

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The interrelationships among nutritional status, living environment, and school performance of first through third grade primary school children living in low socioeconomic areas in Khartoum, Sudan

by

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INTRODUCTION

In most developing countries, the percent of the population under age 15 is estimated to exceed 40% (Population Reference Bureau, Inc., 1991). Primary school children constitute the majority of this percentage. It is unfortunate that the rate of school enrollment in many developing countries is lower than the number expected to be enrolled on the basis of age (Pollitt, 1990). In addition, fewer girls are enrolled than boys in most of these countries. For example, in some Asian countries like Bangladesh, Afghanistan, and Nepal, less than 50% of school-age girls are enrolled in primary schools (Pollitt, 1990).

Associated with low school enrollment in developing countries, there is early dropout, grade repetition, and poor achievement. For example, in the Dominican Republic in the 1984-85 school year, only 53.4% of those enrolled in the first grade were promoted, while about 13% dropped out (Pollitt, 1990). The problems of dropout, grade repetition, and poor school performance add to the economic burden of developing countries. Poorly educated citizens consume basic economic and human resources without providing high economic return (Pollitt, 1990). Among reasons suggested for low enrollment, high dropout rates, grade repetition, and low school performance are the nutritional deficiencies and poor health of primary school children. However, poor nutritional and health status have received little attention as a determinant of school progress.

Demographic Trends in the Sudan

Sudan is the largest country in Africa, with a population of 25.9 million and a diversity of people belonging to over 40 major tribes and speaking over 60 dialects. Individuals under 15 years of age are estimated to constitute 45% of the total population. Both infant births and infant deaths are high. The infant mortality rate is 104/1,000 live births, and the total fertility rate is 6.4. With a high rate of natural increase of 2.9%, the population is expected to double within 24 years (Population Reference Bureau, Inc., 1991).

Sudan has abundant natural resources that offer the potential for agricultural and other economic developments. However, this development has been hindered during the last decade by recurrent droughts, which have prevented crop production in many areas of the country and have resulted in widespread famine. In addition, a massive flood in 1988 damaged most of the agricultural products of that year (Harrison, 1989). These natural disasters have led to massive population movements, particularly to the capital, Khartoum. Refugees from other African countries such as Ethiopia, Uganda, and Chad, seeking refuge from internal problems in their own native countries, also have descended on the capital.

Rural to urban migration, a feature of most urban centers in the developing world, brings great pressure to bear on the meager resources and poorly developed infrastructure of large cities such as Khartoum. It is estimated that 3.9 million people lived in Khartoum in 1989 (Ministry of Planning, 1990). Migration also brings citizens not adapted to life in the city. The influx of migrants and refugees to Khartoum has added to the city's already large number of low income residents. This change, plus a high rate of inflation, have resulted

in a large segment of Khartoum's population living in low socio-economic conditions. These individuals typically live in areas with high population density, poor housing, poor sanitation, and low access to goods and services, such as adequate food, water, and health care. For example, in a recent survey in Khartoum, it was found that families in low socio-economic housing areas were spending more than half of their income on water, since there was no source of water in these areas and families had to buy it from vendors (Hardoy et al., 1990). Most low socio-economic households spent almost all of the remainder of their income on food. The poorest households were having to sacrifice most of their food money in order to meet their need for water. Thus, the economic and human cost of water is high, indeed, and there are children who literally pay for it with their lives (Hardoy et al., 1990).

No recent figures give a detailed picture of housing conditions in Khartoum. An official survey done in low socio-economic housing areas in Khartoum in 1987 showed poor sanitary conditions in about 59% of houses (Ministry of Planning, 1987). For example, almost all houses lacked drainage facilities, and only 31% were connected to a piped water supply. No house had a flush toilet, while one-third used bucket latrines and 59% used pit latrines. The rest have no toilet facility in the home. Houses in the low socio-economic housing areas surveyed were usually built out of mud, with few rooms and a high density of individuals per household.

The Statement of the Problem

Because preschool-aged children are most vulnerable to the synergistic effects of illness and poor nutritional status, they are often used to assess the

nutritional well-being of a group of people. In 1988 a study was carried out with approximately 18,000 children aged 1-5 years living in shanty areas of Khartoum province (Nutrition Department, 1988). Mid-arm circumference was used to indirectly assess protein-energy malnutrition. Using this measurement, approximately 10% of the children surveyed were judged to be severely malnourished. Recent reports from UNICEF, the Food and Agriculture Organization, and other agencies (Department of Nutrition and Department of Health, 1987) on the status of preschool children throughout Sudan found evidence of both long-term and short-term protein-energy malnutrition, a high incidence of diarrhea and communicable diseases, and high infant and childhood mortality rates related to poor health, poor environment, and inadequate food intake. Thus, these recent studies of preschool children indicate that health and nutrition problems are prevalent in the Sudan.

While many nutrition and health surveys focus on the preschool child, the young school-aged child has generally received little attention. However, good health and nutritional status are important for this age group as well. Poor nutritional status among young school-aged children can impair these children's ability to grow at a normal rate and to resist and recover from infection (Pollitt, 1990). Moreover, poor health and nutritional status among this age group may contribute to high rates of school absenteeism, early dropout, and poor classroom performance (Pollitt, 1990). Most studies have focused on the effects of protein-energy malnutrition (PEM) and iron deficiency anemia. Children with mild and moderate PEM, compared to their well-nourished peers, are less physically active, less attentive, less curious, and more dependent on adults. These characteristics contribute to poor reading ability and low verbal and motor skills

(Parker, 1989). In addition, hungry children tend to be nervous, irritable, disinterested, and unable to fully concentrate in the classroom (Parker, 1989). Iron deficiency anemia also appears to contribute to poor learning skills (Soemantri et al., 1985).

Recent statistics show that the total number of primary school children in the state of Khartoum is 313,521, with 155,492 boys and 158,029 girls (Ministry of Education, 1991). The total number of schools is 701. Many of these schools are very crowded. For instance, the average number of students per class has exceeded 100 in some areas with both a high population density and a low number of schools (Ministry of Education, 1991).

Young school-aged children living in Khartoum's low socio-economic housing areas are vulnerable to the synergistic effects of poor nutritional status and illness. Their living environments expose them to a variety of pathogens, making frequent illnesses likely. In addition, if food intake is poor, their ability to resist and recover from illness may be compromised. Since both frequent illness and poor nutritional status have the potential to hinder school achievement, these children may have difficulty adequately learning the skills taught in school.

Therefore, the purpose of this study was to investigate the interrelationships among and between indicators of nutritional status, school performance, and living environment among first, second, and third grade Sudanese children living in low socio-economic housing areas of Khartoum. The specific objectives of the study were to:

1. Assess the children's nutritional status using four indirect measures of nutritional status—height-for-age, weight-for-age, weight-for-height, and food intake frequency,
2. Assess the prevalence of common illnesses among these children during the last school year, and the effect of illness on school attendance,
3. Obtain information on the children's school performance during the last school year using information recorded in school records,
4. Assess selected demographic, living environment, and food environment variables, and
5. Examine the interrelationships among and between each set of variables above.

The following chapters present methodology for data collection, results and discussion, and conclusions and recommendations. The chapters are organized as follows:

— Chapter 2 – General methodology and description of the sample.

— Chapter 3 – Review of literature, specific methodology, and results and discussion regarding housing and the environment.

— Chapter 4 – Review of literature, specific methodology, and results and discussion regarding food behavior, health status, and anthropometric characteristics.

— Chapter 5 – Review of literature, specific methodology, and results and discussion regarding school performance.

— Chapter 6 – Summary and conclusions.

GENERAL METHODOLOGY AND DESCRIPTION OF THE SAMPLE

General Methodology

Khartoum, the capital of the Sudan, is known as the triple capital because it consists of three towns, which are Khartoum North, Omdurman, and Khartoum. The three towns are divided by the White Nile, the Blue Nile, and the Nile Rivers. Three low socio-economic areas, one in each of the three towns, were purposively selected for this study. Each area is heavily populated with migrants from different parts of the Sudan who have settled as permanent residents. The three areas selected were Ombada in Omdurman, El hag-Yousif in Khartoum North, and Arkwait in Khartoum. In each area, two primary schools were randomly selected, one boys' school and one girls' school. The two schools in each area were adjacent to each other and near many homes in that area, which made the homes of the children easily accessible to the researcher and interviewers. Furthermore, Ombada and El hag-Yousif were well-known to all interviewers, who had had prior research experience in the two areas during their course of study at Ahfad University for Women (AUW).

Principals of the six schools were contacted, and permission to conduct the study was obtained. Data were collected in these schools within four weeks during the months of January and February, 1992.

Instrument development

An interview form was designed to obtain information on demographic variables, housing and environmental conditions, food behavior patterns, and health status. In addition, a form was developed to record anthropometric

characteristics and information from children's school records. The interview form was developed in English and reviewed by eight faculty members in the College of Family and Consumer Sciences at Iowa State University, the School of Family Sciences at AUW, and the Department of Home Sciences and the Department of Agriculture, University of Khartoum, Sudan. The expert reviewers were asked to assess the clarity, completeness, and appropriateness of the questions for obtaining data to meet the research objectives. Minor revisions were made in several questions based on the reviewers' suggestions.

After revision of the interview form, a pilot test was carried out using 10 families with children in the first three grades of primary schools in Ombada, Omdurman (one of the study areas). Based on pilot test results, minor modifications were made, resulting in the final version of the interview form (Appendix A). The research instrument and methodology for the study were approved by the Committee on the Use of Human Subjects in Research at Iowa State University.

Selection of the sample

The sample was chosen from male and female students six to ten years old in the first three grades of primary schools participating in the study. One-hundred-ninety-eight students were selected from six schools (Table 1). Eleven students were randomly selected from each of the first three grades in each school, resulting in a total of 33 students from each school. Half of the sample were males and half were females.

To select the random sample, a list of students' names was obtained for each grade, first through third, in each school. A random drawing of 20 names

Table 1. Schools selected for data collection (n=6)

Name of school	Location
Ombada South for Girls	Omdurman
Ombada South for Boys	Omdurman
El hag-Yousif Extension for Girls	Khartoum North
El hag-Yousif Extension for Boys	Khartoum North
Arkwait North for Girls	Khartoum
Arkwait North for Boys	Khartoum

from each list was made by the researcher. After examining students' birth dates, those who did not fall within the age range specified were excluded, and the sample was limited to the first 11 students drawn from each grade whose ages fell within the range specified for the study.

Students in each class were briefed by the researcher and the principal of the school about the study, and those who were selected were asked to inform their parents about the possibility of the researcher and interviewers visiting their homes to obtain a signed, modified informed consent form to assure the parents' willingness for them and their children to participate in the study.

Next, an interviewer visited each potential subjects' home. A modified informed consent form (Appendix B) was read to each mother or female guardian explaining the purpose of the study and the methodology to be

followed. After obtaining the signature of the mother or female guardian, a time was set to interview the mother at her convenience. No mother refused to participate in the study.

Data collection

Four graduates with a B.S. in Family Sciences from AUW were selected as interviewers. All interviewers had had prior experience conducting interviews with mothers at home during their course of study at AUW. Interviewers were selected via personal contact by the researcher. They were trained for a week by the researcher at AUW in how to clarify questions for mothers by reformulating them in a simple language that mothers could understand, and how to write consistent responses on the interview form. As a part of training, interviewers were asked to interview each other in the presence of the researcher. The researcher observed how the interview was conducted as well as clarified questions asked to ensure that quality data were obtained.

The researcher accompanied each interviewer during her first interview to observe the way she conducted the interview as well as the completeness and quality of the data collected. Each interview took 30 to 45 minutes to conduct. At the end of each day each interview form was checked by the researcher for missing information or incomplete answers and returned to the interviewer for clarification the next morning.

The anthropometric measurements of the children (weight and height) were obtained by the researcher at school. About five minutes were spent to measure and record data for each child. In addition, school attendance and performance records were obtained from school administrators for each subject

and recorded by the researcher. School principals and teachers were very cooperative in providing needed information.

Data coding and analysis

Data were coded for subsequent computer processing and analysis. The Statistical Package for the Social Sciences (SPSS, Inc., 1990) computer program was used to analyze the data. Frequencies and descriptive statistics were obtained for all variables. Tests of significance and correlations were computed for selected variables, as further described in subsequent chapters.

Description of the Sample

Selected demographic characteristics of the 198 children participating in this study are presented in Table 2. The mean age was 8.11 years, with ages ranging from six to ten years and most with ages of seven to nine years (94.4%). The sample's age in months ranged from 77 to 123 months. About 22% of the sample did not have younger siblings, while the majority (73.2%) had from one to three younger siblings. However, the number of older siblings was quite varied, ranging from 0 to 11.

Selected demographic characteristics of the children's parents are presented in Table 3. Over 80% of the fathers were able to read and write. Educational achievement of the fathers varied from none to university training. This variability was also reflected in the jobs held by the fathers. More than one fourth of the fathers were laborers (28.8%) and about 21% were merchants, ranging from those owning small shops to those selling a few items in the open market.

Table 2. Characteristics of children participating in the study (n=198)

Characteristic	Frequency	Percent
Age in years		
6	5	2.5
7	47	23.7
8	73	36.9
9	67	33.8
10	6	3.0
Age in months		
77-83	5	2.5
84-89	21	10.5
90-95	26	13.0
96-101	36	18.0
102-107	37	18.6
108-113	34	17.0
114-119	33	16.6
120-123	6	2.5
No. of younger siblings		
0	43	21.7
1	49	24.7
2	63	31.8
3	33	16.7
4	8	4.0
5	2	1.0
No. of older siblings		
0	27	13.6
1	35	17.7
2	25	12.6
3	22	11.1
4	23	11.6
5	20	10.1
6	24	12.1
≥7	22	11.1

Table 3. Characteristics of the children's parents

Characteristic	Frequency	Percent
Father		
Able to read	168	84.8
Able to write	166	83.8
Highest level of education		
None	16	8.1
Khalwa (religious education)	13	6.6
Primary	55	22.8
Junior secondary	30	15.2
High secondary	49	26.7
University or post university	23	11.6
Missing	12	6.1
Occupation (primary)		
Laborer	57	28.8
Small business owner	42	21.2
Government officer	30	15.2
Work outside country	20	10.1
Self-employed	13	6.6
Professional	12	6.1
Retired	9	4.5
Technician	6	3.0
Missing	9	4.5
Hours/day worked outside home		
All day	30	15.2
At least half day	126	63.6
Less than half day	0	0.0
Does not work outside home	7	3.5
Missing	35	17.7
Tribe		
Jaalien	41	20.7
Shigeia	32	16.2
Danagla	24	12.1
Mahas	20	10.1
Other	81	31.9

Table 3. Continued

Characteristic	Frequency	Percent
Mother		
Able to read	125	63.5
Able to write	120	60.6
Highest level of education		
None	70	35.4
Khalwa (religious education)	13	3.5
Primary	55	27.8
Junior secondary	36	18.2
High secondary	23	11.6
University or post university	6	3.0
Missing	1	0.5
Occupation (primary)		
Housewife	177	89.4
Self-employed	9	4.5
Professional	6	3.0
Government officer	3	1.5
Technician	1	0.5
Missing	1	0.5
Hours/day worked outside home		
All day	0	0.0
At least half day	17	8.6
Less than half day	2	1.0
Does not work outside home	177	89.4
Missing	1	0.5
Time family lived in capital		
>10 years	177	89.4
5-10 years	12	6.1
<5 years	8	4.0
Family's home area (for those living in capital 10 years or less (n = 20)		
Northern Sudan	10	50.0
Western Sudan	6	30.0
Central Sudan	2	10.0
Eastern Sudan	1	5.0
Southern Sudan	1	5.0

Other fathers worked in relatively skilled positions as government officers, professionals, or technicians, while approximately 17% were self-employed or worked outside of the country. Most of the fathers spent at least half the day at work (63.6%). Fathers belonged to 32 major tribes in the Sudan, with the majority of them belonging to four major Northern tribes, i.e., Jaalien, Shigeia, Danagla, and Mahas (68.1%).

The majority of the children's mothers were able to read and write (about 60%) but the majority had had either no formal education or only a primary school education (66.7%). Both reading and writing skills and formal education were lower among these children's mothers than among their fathers. Most mothers were housewives (89.4%), and only 9.5% worked outside the home. Those who worked outside the home worked a half day or less.

The majority of families had lived in the capital for over 10 years (89.4%). Half of those who had moved to the capital during the last ten years came from the Northern part of the Sudan (50.0%). The other half came from other parts of the country.

Several statistical relationships were computed between the demographic characteristics of the children in the three geographic areas in terms of age ranges, number of younger siblings, and number of older siblings. No significant relationship was found between the children's demographic characteristics or between the demographic characteristics of children living in the three areas. In contrast to the children, several statistically significant relationships were found between the demographic characteristics of the fathers. For example, the father's level of education was associated with both reading and writing skills and occupation. Fathers who reported either no education or khalwa (religious

education) were also likely to report that they could not read (x^2=157.00, df=5, p=.000) or write (x^2=155.02, df=5, p=.000). Fathers who could not read were also likely to be unable to write (x^2=183.41, df=1, p=.000). Similarly, fathers with no education or khalwa were likely to work as laborers, while those with the highest levels of education were more likely to work as professionals, technicians, or government officers (x^2=59.47, df=9, p=.000). Consistent with the statistical associations above, the majority of fathers who could not read (69.6%) or write (70.8%) were employed as laborers (x^2=183.42, df=1, p=.000).

Similar to fathers, mothers with no education or khalwa education were mostly unable to either read (x^2=168.92, df=5, p=.000) or write (x^2=165.76, df=5, p=.000). On the other hand, mothers who were able to read were also likely to be able to write (x^2=176.84, df=1, p=.000). Not surprisingly, the education level of the mothers was significantly associated with the education level of the fathers (r=.571, p=.000).

Finally, statistical tests were performed to investigate differences in the demographic characteristics of the parents living in the three geographic areas of the study. No significant difference was found between parents' characteristics in the three geographic areas, indicating that parents from the three areas were demographically similar in terms of school achievement, reading and writing skills, and occupation.

HOUSING: ENVIRONMENTAL AND LIVING CONDITIONS

Literature Review

The housing and surrounding environment are the most influential factors affecting people's lives, health, and well-being. An adequate quality of life depends on having a clean, decent, safe home where a family can live. In Third World countries, a sizeable number of the population are living in degraded environments, especially in the urban centers and big cities (Hardoy et al., 1990).

All factors of the physical environment, such as air, water, space, temperature, land, and light, and many of the biological environment interact with social factors such as poverty, educational achievement, food availability, and migration patterns to influence the quality of people's lives, including their housing and health. Poor housing and living conditions often are associated with high rates of mortality and morbidity. Most public health efforts regarding housing have entailed the provision of an adequate and safe water supply, safe disposal of human and other solid wastes, provision of drainage, control of insects that transmit diseases, control of indoor and outdoor pollution, and protection against climatic extremes. In many Third World countries, these public health housing concerns either do not exist or are not of high priority on governmental lists (Hardoy et al., 1990).

Water

Since 1980-1989 was the United Nations' International Decade of Water, more information is available on the provision of adequate and safe water in Third World countries than on other aspects of housing and the living

environment. An adequate and safe water supply can help reduce the incidence of infectious diseases, limit the spread of communicable diseases, prevent diarrheal deaths among children, assure safe food for the family, and spare time and energy for women and children who are responsible for carrying water home from far places (Okun, 1988). White et al. (1972) estimated the average East African rural woman used about 9% of her estimated 2,840 kilocalorie (kcal) daily intake in providing water. Child-rearing or childbearing, when combined with water drawing, may account for a sizable share of the daily caloric demand (McJunkin, 1983). Children also benefit from a safe water supply because the heaviest burden of morbidity and mortality from water-related disease falls upon them.

Water can affect a human's health in many ways. First, water can be a carrier for many pathogens that cause microbiological diseases, such as typhoid and cholera. Second, adequate water is considered very important for controlling diseases related to poor personal hygiene. For example, safe water can reduce diarrheal disease and skin and subcutaneous infections by 50%, trachoma by 60%, inflammatory eye disease by 70%, and typhoid by 80% (McJunkin, 1983). Third, for some diseases transmitted by insects, water is a required medium for development. Mosquitos are a good example; they carry malaria, which is widespread in some developing countries such as the Sudan. Finally, the process of collecting water from lakes, streams, or bore-holes may expose people to a variety of diseases through skin penetration, such as is the case with schistosomiasis (Galway et al., 1987). An adequate and safe water supply also enhances agricultural and industrial production.

Overall, preventing water-related diseases can help reduce morbidity, increase productivity, and enhance children's mental and physical development (Yankauer, 1988). For example, a study was done in Lesotho, Southern Africa, in 1985 to study the interrelationship between drinking water source, diarrheal morbidity, and child growth in villages with both traditional and improved water supplies. It was found that children, whose families relied exclusively on the new, installed water supply for their cooking needs and drinking water, grew 0.438 cm and 235 g more in six months than the children whose families were partially or exclusively using the traditional source of contaminated water. Results suggest that an improved water supply can benefit the health of preschool children (Esrey et al., 1988).

In an estimation of the percentage of the population with access to safe water and adequate sanitation facilities, 65% of the urban population in Africa are thought to have access to safe water, while only 26% are thought to have the same access in rural areas. Sanitation facilities are also inadequate. Only 53% of the African urban population are thought to have access to adequate sanitation facilities. In rural areas, only 21% have access to such facilities (Galway et al., 1987).

In areas lacking running tap water, water is usually drawn and stored for use. Storage containers may be contaminated, and water usually stagnates if it is not refrigerated. This type of water is susceptible to contamination with pathogens, and, when used in preparing food or baby formulas, results in many health problems (Galway et al., 1987). Studies have shown that when sources of water are close to individuals' homes it increases water consumption and

reduces the amount of energy and time spent on carrying water home (Hardoy et al., 1990).

In most of the poor urban areas in Third World countries, people are spending a sizeable amount of their incomes to buy water. This expenditure diminishes the amount of money they have to spend on food, and hence influences their nutritional status. For instance, in a study done recently in the state of Khartoum, the capital of the Sudan, on prices spent for buying water in some communities, it was found that the average household spent more than half of its income on water. The amount of water purchased and the amount spent for the water tended to be equivalent for middle income and poor families. As a result, the poorer households tended to spend a greater proportion of their income on water. This large income allocation has potentially serious consequences, especially for the children, by exacerbating the prevalence of malnutrition and contributing to the high level of mortality (Hardoy et al., 1990).

Sanitation

Among other factors, lack of adequate sanitation facilities can contribute to health problems. This situation is typical in many of the big cities of Third World countries, especially among the urban poor living in overcrowded, cheap rental accommodations or settlements. About 30-60% of the population in most Third World cities are estimated to lack adequate sanitary facilities. For example, data collected by the World Health Organization (WHO) in preparation for the United Nations Water Conference in 1977 shows a rough estimate of only about one-third of the population in developing countries with adequate sanitation services (Kalbermatten et al., 1984).

Individuals without adequate sanitation facilities often have no means to dispose of human waste and other waste water, known as sullage (Hardoy et al., 1990). Urination and defecation in surface water or in open fields can lead to the transmission of a large number of diseases, including schistosomiasis, hookworm, and cholera. The number and variety of fecally-transmitted diseases are greater in the tropical and sub-tropical regions. In these regions, heat and humidity create ideal conditions for pathogen survival. Furthermore, the malnutrition that is endemic among many of the urban poor contributes to high susceptibility to infection. The result is that poor sanitation becomes one of the chief causes for the spread of hookworm, diarrhea, enteritis, cholera, and typhoid (Rybczynsk et al., 1982).

The type of latrines prevalent in most of the developing countries contributes to unsanitary conditions. For example, in the Khartoum area two public sewer systems served only 3% of the urban population, but about 80% have access to some system of excreta disposal (World Health Organization, 1982). A type of latrine common in the low socio-economic settlements is the dry pit privy, which receives only feces and urine and can become wet through the addition of water used for anal cleansing or by the pit being dug below the ground water table. The major disadvantages of wet pits are the increase in fly and mosquito breeding caused by excessive water in the pit and the possibility of infiltration of contaminated water into the surrounding soil (Rybczynsk et al., 1982).

A second kind of latrine common in poor urban areas in the Sudan is the bucket latrine. The excreta are deposited directly into a container that is periodically removed for disposal. Although it has an advantage of minimal

capital outlay on the part of the user, the bucket latrine is unhygienic, offensive, and detrimental both to environmental and health conditions.

Another form of household refuse is what is known as sullage or grey water (waste water). This waste water is simply deposited on the ground around the house or in street drains. When sullage drains are available in the home, they are notoriously difficult to maintain. They frequently become blocked by food waste or refuse, and act as breeding grounds for flies and mosquitos. Hence, they increase susceptibility to infection, especially among children who frequently play around drainage areas.

Alternatives for better sewage systems usually have poor success rates in low income areas because of the problem of cost, not only in terms of construction, but also in terms of the high cost for poor people to connect to the systems. Another problem is that any piped sewage system requires large volumes of water to carry solids through pipes to prevent blockages. Such high water usage is rare in low income housing areas (Reed, 1990).

Garbage

In many of the developing countries, it has been estimated that 30-50% of solid waste generated within urban centers remains uncollected (Cointreau, 1982). The uncollected waste most of the time is dumped in streets, spaces between homes, open land, and drainage ditches. Scavengers and animals typically scatter the piles of garbage, which serve as food or breeding media for disease vectors, primarily flies and rats. The absence of proper garbage disposal has the potential to cause health problems, arising both from pathogens in refuse itself and from disease vectors which breed or feed on it. In a pilot project done

in Olinda/Recife, Northeast Brazil, to develop low-cost garbage collection and disposal in a low-income settlement area, a test for intestinal parasites was carried out on 272 of the 1,350 inhabitants of that area. Results were negative in only nine of them. One hundred fifty persons had three different types of parasites, while 93 had two, and only 11 had one (Hardoy et al., 1990). As a result, uncollected garbage is a serious health-hazard for all inhabitants, especially for children who play on streets or open areas contaminated with refuse (Cairncross and Feachem, 1983).

The poorest areas of urban centers usually suffer most from poor garbage collection services. The problem is usually complicated by lack of space within homes to store garbage. The poor garbage collection in poor areas is often due to the fact that many houses are built close together, with access only by pathways too narrow to allow garbage collection trucks to get through. In addition, poor people can neither afford to pay for garbage collection services nor to buy garbage collection sacks.

There is a need to find a more effective system to remove garbage in poorer areas. There is also a need to address the health problems faced as a result of uncollected garbage within household settlements in those areas.

Animals

Many of the poor households in urban centers of Third World countries keep some domestic animals inside or around their homes. This fact is mainly due to economic reasons. However, domestic animals also serve the purpose of providing food, labor, personal safety, and companionship. For example, cattle and goats are used for milk production, sheep for meat and fiber and some

religious purposes, horses and donkeys for transportation, dogs for personal safety and companionship during hunting or cattle and goat grazing, cats for rodent control, and poultry for food and income generation from chicken and egg selling (Hart, 1985).

Due to limited outdoor space in low-income residential areas in most of the urban centers in developing countries, animals are often kept in small pens inside the house or in a pen attached to the house. If the pen is crowded, the animals are usually free to wander during the day and are only kept inside the pen during the night. These wandering animals often feed on garbage piles in the street. Unfortunately, these garbage piles are often contaminated with pathogens that transmit diseases to the animals. In turn, the pens where the animals are usually kept and the areas in which they wander, including the inside of homes, become disease-contaminated. Because many animal diseases are transmittable to humans, it is very important to have an animal population free from diseases that may affect humans' well-being. Dykstra reported, in 1961, that some 80 different diseases are recognized as transmittable from animals to man. Of course, with the development of new disease investigation procedures, this number would have increased since 1961. Examples of transmittable diseases between animals and man are cholera, diphtheria, amebic dysentery, bacillary dysentery, tuberculosis, and infectious jaundice (Dykstra, 1961). Many such diseases are preventable through immunization or vaccination. However, other diseases may be controlled only by sanitation and isolation of infected animals.

Children are especially susceptible to infections by diseased animals as they often play in areas visited by infected animals. It is important to keep children away from infected animals so as to minimize contacts, and hence the transmission of diseases.

Home gardens

Growing vegetable gardens at the household level is one means of improving the food intake of individuals and families. Although the importance of growing vegetables at home has been emphasized by agricultural education and extension in the Sudan, implementation of the idea has been constrained for several reasons. Lack of enough water at the household level, lack of enough land at or near homes, and lack of fertilizer, seeds, and proper planting instructions are among the reasons responsible for the absence of home vegetable gardens (Gezzoli, 1988). The School Gardening and Nutrition Education Division, Ministry of Education, has sponsored training programs in the Sudan to raise the awareness of students at the primary school level and community members about home gardens. These programs were held at different locations in the country and were aimed at improving nutritional status among household members. The objectives of the program were to encourage families and groups to grow small vegetable gardens and raise chickens and other food goods to improve families' nutritional status via increased consumption of nutritious foods from their gardens. The project was established with support from several organizations after the 1984-85 famine. The project was not widely adopted in the Khartoum province as a result of lack of water in many areas of Khartoum, as well as the poverty of people in many

low socio-economic housing areas in Khartoum (Gezzoli, 1988). Evaluations of the effectiveness of home gardens for increasing food consumption and improving nutritional status in developing countries were not located in the professional literature.

Methodology

Data collection

Several questions on the interview form were used to obtain data on the housing conditions and living environment of the sample. Mothers or female guardians of the subjects under study were asked questions regarding the length of time the family had lived in their present house, the ownership of the house, number of rooms in the house, number of people living in the household, the sources and storage of drinking water, and sanitation facilities, such as the availability and type of toilets and garbage disposal. To assess the availability of selected household goods and services, these females were also asked about the availability or ownership of six services or items in the household including electricity, refrigerator, radio, television, car, and sewing machine.

To determine if selected domestic animals which could be a source of food products were raised by the household, the mothers or female guardians were asked questions on whether they raised goats, chickens, or pigeons and, of so, what kind of animal product(s) the household utilized from these animals. Questions on how these animals were housed or sheltered were asked to help determine the environmental sanitation of households. A related question asked whether or not the household raised a kitchen garden and, if so, if vegetables and/or fruits were utilized from that kitchen garden.

Data analysis

Frequencies and percentages were calculated for all variables. A wealth score was computed by assigning one point for each of five items the household had or owned, including refrigerator, radio, television, car, and sewing machine. Electricity was not included in this score because its availability was related to geographic location rather than ability to afford electricity. The total points earned by a household were used as an indicator of wealth of the family. Spearman and Pearson correlation coefficients, t-tests, and chi-square values were computed to examine the interrelationships among demographic characteristics, housing conditions, and living environment variables. Relationships between selected variables were also investigated using analysis of variance and post-hoc t-tests.

Results and Discussion

A description of the persons living in the households of the children in this study is presented in Table 4. The total number of people living in the households ranged from 3 to 22 persons, with most households containing 8 to 12 persons. Thus, large households appear to have been the norm for the families in this study. A relatively large household size is common in many low socio-economic areas in urban cities of developing countries. For example, Aina (1990) reported a 1984-86 survey undertaken in Olaleye-Iponri, a densely-populated, predominantly low-income settlement in Lagos, Nigeria. In that area, household sizes of between 5 and 8 were reported by almost half of the respondents, and household sizes of between 9 and 11 for 13%.

Table 4. Description of persons living in the households of the subjects (n=198)

Variable	Frequency	Percent
Number of people in household		
3-7	56	28.3
8-12	111	56.0
≥13	31	15.7
Persons in household		
Grandparents		
None	142	71.7
1	38	19.2
≥2	18	9.1
Mother		
None	1	0.5
1	197	99.5
Father		
None	16	8.1
1	182	91.9
Father's other wives		
None	191	96.5
1	6	3.0
2	1	0.5
Sisters of child		
0	19	9.6
1	46	23.2
2	51	25.8
3	29	14.6
4	24	12.1
5	22	11.1
≥6	7	3.5

Table 4. Continued

Variable	Frequency	Percent
Brothers of child		
0	15	7.6
1	42	21.2
2	47	23.7
3	44	22.2
4	26	13.1
5	13	6.6
≥6	11	5.5
Other relatives		
0	128	64.6
1	25	12.6
2	21	10.6
≥3	23	12.0
Others, not relatives		
0	194	98.0
1	3	1.5
≥2	1	0.5
Other children <7 years living in household		
0	43	21.7
1	49	24.7
2	63	31.8
≥3	43	21.7
Other children ≥7 years and still in school living in household		
0	27	13.6
1-2	60	30.0
3-4	45	22.7
5-6	44	21.7
≥7	22	11.1

About 28% of the sample had at least one grandparent living in the household. The child's mother was absent from only one household, and the child's father from only 16. Only seven households reported that the household included the father's second or third wife in addition to the child's mother. The number of sisters and the number of brothers of the subjects living in the household ranged from 0 to 9, with most children having sisters and brothers in the range between 1 and 5 (86.9% and 86.8%, respectively). Other than these relatives, the majority of the children did not have others living in their households. Over 75% of the subjects had one or more siblings living in the household who were under seven years old, while about 86% of the sample had one or more siblings above age seven, still in school, and living in the household.

Only one significant relationship was found between the descriptive characteristics of the father and the household size. The total number of people in the household was negatively correlated with the father's educational achievement ($r=-.2163$, $p=.002$), with more people in the households of fathers who had attained a lower level of schooling.

A description of the subjects' homes is presented in Table 5. The majority of the subjects' families had lived in their present homes for over nine years (61.6%). Furthermore, the majority of families owned their houses (73.2%). Low income families in the Sudan usually buy from the government a piece of land of no more than 300 square meters on the outskirts of cities, described as third class areas in the public housing plan. This classification affects the type and standard of buildings as well as the effectiveness of basic infrastructure and services, such as water, roads, drainage, and waste disposal (Hardoy et al., 1990).

Table 5. Description of the subjects' homes (n=198)

Variable	Frequency	Percent
Length of time in present house		
<1 year	12	6.1
1-3 years	20	10.1
4-6 years	21	10.6
7-9 years	23	11.6
>9 years	122	61.6
House ownership		
Owned by family	145	73.2
Rented by family	48	24.2
Other	5	2.5
Number of rooms in house		
1-2	29	14.6
3-4	78	39.4
5-6	77	38.9
7-8	14	7.0
Where households obtained water[a]		
Tap in household	181	91.4
Vendor	37	18.7
Public tap	17	3.5
Other	4	2.0
How households stored water[a]		
Covered metal, plastic, or clay container	150	75.8
Covered barrel	62	31.3
Uncovered metal, plastic, or clay container	30	15.2
Uncovered barrel	11	5.6

[a]Multiple responses possible

Table 5. Continued

Variable	Frequency	Percent
Type of toilet used by household[a]		
Pit latrine inside house	166	83.8
Flush toilet	25	12.6
Other	7	3.6
Household garbage disposal[a]		
Picked up by garbage cart	118	59.6
Throwing on outside garbage pile	96	48.5
Burning	27	13.6
Burying in ground or other	14	7.1
Services or selected items in household[a,b]		
Electricity	177	89.4
Television	151	76.3
Radio	147	74.2
Refrigerator	136	68.7
Car	55	27.8
Sewing machine	53	26.8

[a]Multiple responses possible

[b]All items in this category except electricity used in a calculation of wealth score

Houses consisting of between three and four rooms accounted for 39.4%, and those with five to six rooms 38.9%. About 14.6% of these families were living in only one to two rooms, and only 7.0% occupied houses with more than six rooms.

In regard to sources of water, the majority of the sample had water piped to their homes (91.4%). However, 18.7% of the families bought water from vendors, indicating insufficient water availability. Sources such as public taps or

wells were used by only 5.5% of the subjects' families. For those who stored water in the household, many types of storage containers were used, such as barrels and metal, plastic, or clay containers, and most were covered.

An important aspect of housing conditions, with far-reaching implications for the health status of residents in low-income housing, is the nature and state of basic services and facilities in houses, such as the availability and type of toilets, provision of drainage and sewerage, and garbage disposal. The predominant type of toilet used by the families in this study was a pit latrine inside the home (83.8%). Only 12.6% had a flush toilet inside their homes. This statistic is consistent with the earlier UNDP report (Rybczynsk et al., 1982), which indicated that about 80% of the population in Khartoum had access to some excreta disposal other than sewer systems. Normally toilet facilities are extensively shared by all members of the family. However, the picture for low socio-economic families in the Sudan may be better than that for many similar areas in other developing countries. For example, Aina (1990) reported that in Iponri, Nigeria, 28% of respondents had no access to toilet facilities, and those who had access to toilet facilities only had the outhouse bucket latrines.

For the purpose of garbage disposal, over half of the families reported that their garbage was picked up by garbage carts twice a week (59.6%). However, about half of the subjects' families threw garbage on outside garbage piles. Few families burned or buried their garbage.

The goods and services owned or used by these families varied. In regard to electricity, virtually all houses had direct, legal supplies (89.4%). However, it is common to have regular power cuts and loss of power during most of the daytime, especially in summer. Approximately three-quarters of the families

had refrigerators. However, less than one-third had either a car or a sewing machine.

A number of demographic variables were significantly correlated with the length of time that the family had lived in their house. The length of time that the family had lived in the house was negatively correlated with father's educational achievement (r=-.1935, p=.004) and positively correlated with total number of people in household (r=.3161, p=.001). Thus, families who had lived a longer period of time in their home tended to be headed by males with lower educational achievement and to contain a larger number of individuals. Those who had lived over nine years in their present home were more likely to own their house than those with shorter residence (x^2=20.32, df=1, p=.000). Similar findings were reported by Misra (1990) for Chheet-Pur, India, where most low income families' houses were owner-occupied, and only 23% of the families were tenants.

Those families in this study who owned their houses were likely to have more people living in the house (p=.041) as well as a larger number of rooms (p=.000). The number of rooms in the household was also positively correlated with father's educational achievement (r=.1906, p=.001), and significantly related to the father's primary occupation (F=53.83, df=7, p=.002). Therefore, fathers who were either better educated or who worked with the government or owned small businesses were likely to own houses with a larger number of rooms.

The presence of piped tap water inside the house was significantly related to the number of rooms in the house (p=.000) and to the father's educational achievement (p=.023). In general, those homes with piped water tended to have more rooms than those without and to be headed by men with a higher level of

education. Having a tap inside the house was also related to the area in which the family lived (x^2=25.62, df=2, p=.000). For example, all of the families who participated in this study in the Khartoum area had tap water inside their homes. On the other hand, about 97% of those who lived in Khartoum North and only about 77% of the families in Omdurman had tap water inside their homes. These facts explain the finding that 97.3% of the families in this study who bought water from vendors were from the Omdurman area, and those who bought water were not likely to have a tap inside the home (x^2=83.83, df=2, p=.000). Cairncross (1990) reported that in Khartoum some 300,000 people depend on the services of about 6,000 vendors, and poor households often pay many times more per liter than richer households. Larger size households, which are likely to consume more water, were most likely to buy water from vendors (p=.038).

Sinnatamby (1990) reported that the pit latrine is still by far the most common sanitation system in most of the low socio-economic areas in Third World countries, mainly because it is the cheapest and simplest to operate. Similar findings emerged in this study. About 83.8% of the sample had pit latrines, and only 12.6% used flush toilets. Those who had flush toilets mainly lived in the Khartoum area (x^2=12.73, df=2, p=.002), and families who had mainly pit latrines lived in the Khartoum North area (x^2=11.26, df=2, p=.004). The presence of a flush toilet was significantly related to the number of rooms in the house (p=.000). Those who had flush toilets tended to have a larger number of rooms in the house and to be headed by fathers who had higher levels of educational achievement (p=.019).

It appears that garbage collection services were not adequate in some areas of the study. Garbage disposal and collection were significantly related to the area in which the family lived, regardless of whether the means of disposal and collection was by garbage cart (x^2=78.82, df=2, p=.000) or by throwing on an outside garbage pile (x^2=65.88, df=2, p=.000). In this study the Khartoum area had the best garbage collection services via garbage carts (98.5%), while a little over half of the families in the Khartoum North area (57.6%) and only 22.7% in the Omdurman area had the same service. On the other hand, more families in the Omdurman area disposed of their garbage on an outside pile (77.3%) compared to less than 10% in the Khartoum area. Cuentro and Gadji (1990) reported that an estimated 30 to 50% of solid waste generated within urban centers of developing countries is left uncollected, and this figure might even be higher in some cities.

The availability of selected services or items in the household was related to several variables. Electricity was significantly associated with area (x^2=29.08, df=2, p=.000), with more families in the Omdurman area without electricity services compared to Khartoum North and Khartoum. The availability of electricity also helps explain the significant relationship between owning a refrigerator (x^2=14.84, df=2, p=.001) or a television (x^2=11.10,df=2, p=.004) and the area in which the family lived. More families with refrigerators and television were in Khartoum and Khartoum North than in Omdurman. The father's occupation was related to owning some items, such as a refrigerator (x^2=18.93, df=3, p=.000), radio (x^2=25.46, df=3, p=.000), television (x^2=16.33, df=3, p=.001), and car (x^2=17.35, df=3, p=.001). In general, families in which the father had a higher paying occupation, such as government officers or owning a small business, tended to own these items. Similarly, father's educational achievement was

significantly related to owning a refrigerator (p=.000), radio (p=.032), and television (p=.017). Significant relationships were also found between the number of rooms in the house and having a refrigerator (p=.000), radio (p=.000), television (p=.000), car (p=.000), and sewing machine (p=.002), with a larger number of rooms associated with families who owned those items.

Statistical relationships between the wealth score, described in the data analysis section, and the demographic variables were examined. Excluding television from the wealth score, the three areas of the study were not significantly different in terms of the wealth score. When including television in the score, area was significantly related to the score (p=.029). This could be explained by the fact that fewer people in the Omdurman area had televisions due to the lack of electricity in some homes. The wealth score was also positively correlated with father's educational achievement (r=.2658, p=.000) and the number of rooms in the house (r=.5224, p=.000), and was significantly related to father's occupation (x^2=39.91, df=3, p=.000). Fathers who were government officers or owned small businesses tended to have higher wealth scores than those who were laborers.

A description of the animals and gardens reported by the households is presented in Table 6. Approximately one-third of the sample raised goats. The number of goats ranged from 1 to 11, with the majority of families who owned goats using goat milk for food, but only about one-half eating meat from their goats. Most families who owned goats kept them in an enclosed pen inside the house (81.5%), contributing to better sanitary conditions in the household compared to those families who allowed their goats to wander in the house. On the other hand, a little over one-third of the sample raised chickens or pigeons,

Table 6. Description of the animals and gardens reported by the households

Variable	Frequency	Percent
Goats owned by households (n=198)		
Yes	65	32.8
No	133	67.2
Number of goats (n=65)		
1	17	26.2
2	20	30.8
≥3	28	43.9
Household's use of goat products for food (n=65)[a]		
Meat	34	81.5
Milk	60	92.3
How goats were kept in household (n=65)		
Enclosed pen in house	53	81.5
Allowed to wander in house	12	18.5
Chickens or pigeons owned by household (n=198)		
Yes	73	36.9
No	125	63.1
Number of chicken or pigeons (n=73)		
1-4	20	27.4
5-8	17	23.3
9-12	20	27.4
>12	16	21.9
Household's use of chicken and pigeon products for food (n=73)[a]		
Eggs from chickens	49	67.1
Meat from chickens or pigeons	61	83.6
How chickens or pigeons were kept in household (n=73)		
Enclosed pen in house	67	91.8
Allowed to wander in house	6	8.2
Kitchen garden raised by household (n=198)		
Yes	9	4.5
No	189	95.5

[a]Multiple responses possible

and the number ranged from 1 to 98. About two-thirds of these families used eggs from their chickens as food, and 83.6% used meat from chickens and pigeons. Chickens and pigeons were kept in enclosed pens inside the household by over 90% of the families who owned these animals.

Kitchen gardens were rarely cultivated by families in the low socio-economic areas included in this study. Only 4.5% of the sample raised a kitchen garden. This may be due to lack of space inside the housing compound, insufficient water, or both.

Correlation coefficients and tests of significance were calculated to determine the interrelationships between having various animals or a garden and demographic factors. Raising goats was more common among households headed by fathers with low educational achievement ($p=.036$). Similarly, the chi-square test reveled a significant difference between raising goats and the father's occupation ($x^2=8.14$, $df=3$, $p=.043$). More fathers who were laborers or small businessmen raised goats than government officers, professionals, or technicians. Furthermore, those who raised goats were also likely to raise chickens ($x^2=11.98$, $df=1$, $p=.001$).

Implications

An analysis of the housing and living conditions of the sample described in this chapter reveal both potentially positive and negative health implications for the children in this study. Three potentially negative implications were demonstrated by the data. First, a majority of the sample came from large-sized families with more than five total people living in the household. According to the findings in this study, a majority of the children lived in small houses with

fewer rooms compared to the number of people in the household. Over one-fourth of the sample lived in extended families, and a majority of the children had several siblings who were still in school and lived in the household. Given the low socio-economic status of the families and the large number of people in the households, families headed by fathers with low paying jobs may have found it difficult to meet basic food, clothing, and shelter needs. Indeed, fathers with lower educational achievements and/or lower paying jobs tended to head households with a larger number of people, putting an even greater strain on these families' meager resources. The households of these fathers also tended to have fewer rooms and a lower standard of basic sanitation services (such as lack of piped water or flush toilets).

Second, housing with adequate provision of safe water, sanitation, and other basic needs is important for the health and welfare of the children. Crowded housing in hot environments with poor sanitation encourages the spread of disease pathogens. Water and toilet facilities were available to a majority of the households, but the sanitary conditions of the water and toilets are not known. According to Hardoy et al. (1990), water in piped systems using old and leaky distribution pipes is often of doubtful quality due to the risk of contamination by ground water and sewage. Water sources in the three areas of this study were mainly wells that were connected to the piped system. On the other hand, the predominant type of toilet was the pit latrine which is a deep room-like structure with a cement roof and a small opening in the ground surface level over a hole dug in the ground. This toilet type was often dug to the ground water level, which increases the risk of contamination of well water with excreta from these toilets.

In contrast to the widespread availability of water and toilet facilities, garbage disposal was inadequate for almost half of the sample,most of whom lived in the Omdurman area. Uncollected refuse may foster stagnant pools that attract insects and breed harmful microorganisms, and thus become a serious health hazard, especially for children who play on streets or open ground contaminated with refuse. Refuse piles are also a fire hazard.

The third finding with potentially negative health implications relates to the availability of food produced at home. The availability of food sources, especially protein sources, to the household can have an impact on children's nutritional status and health. Only one-third of the sample raised goats, pigeons, or chickens, and few raised gardens. With the high prices of food in the Sudan, low socio-economic families might find it difficult to purchase adequate nutrients for their children, and thus raising their own food might be an important supplementary food source. However, on a more positive note, more socio-economically depressed families, as measured by the father's educational achievement and occupation, were the most likely to supplement their food supply by raising food animals.

The housing and living conditions of the sample described in this chapter also revealed several findings with potentially positive health implications for the children in this study. For example, the presence of both parents in the homes of most children reflects the potential for emotional support from both parents. Furthermore, the majority of the families owned their homes and had lived in the area for more than nine years, which made them relatively secure and settled. The majority of the sample also had a radio and/or television, which provided good means of communication for the family. The availability

of refrigerators to the majority of families possibly helped them store food longer, reduce the risk of food spoilage, and saves time in food shopping. Finally, the majority of families kept their animals in enclosed pens contributing to sanitary household environments and reducing risks of animal-to-human transmitted diseases.

FOOD BEHAVIOR, HEALTH STATUS, AND ANTHROPOMETRIC CHARACTERISTICS

Literature Review

Food behavior

Food behavior has been defined as "an individual's response to stimuli related to the selection, procurement, distribution, manipulation, storage, consumption, and disposal of food" (Bass et al., 1979, p. 7). Thus, the term "food behavior" encompasses all aspects related to acquiring and consuming food. Food behavior differs dramatically among cultures. For example, in some cultures household or family members eat together, while in others individuals eat alone. Similarly, in some cultures, like most in the U.S., separate servings of food are given to each individual, while in others, such as the Sudan, a shared pot or dish is the usual pattern (Jelliffe et al., 1989).

The uneven distribution of food among family members is a problem experienced in many families. Like in many other African countries, it is a custom in the Sudan for grown males to eat before other members of the family and, thus, receive the better portions of the meal. In poor families, little food is generally left for other family members, especially for those who eat last (i.e., women and children) and those who get the last portion of what food was available (Shazali, 1977). Certain cultural beliefs also prevent some people from eating certain nutritionally valuable foods. For example, many Sudanese small children are prevented from eating eggs because of the belief that eggs cause deafness or baldness (Shazali, 1977). Withholding food from children with

diarrhea is another harmful practice that may adversely affect nutritional status (Jelliffe, 1968).

At the household level, the amount of food available to people may be inadequate due to poverty, which often puts certain foods beyond the budget of the family. This circumstance is especially the case with regard to expensive animal protein. At the community level, families may find that certain foods are not available as a result of low production, unsuitable climate or soil, and defective food distribution, marketing, or storage facilities. Like many developing countries, Sudan suffers from the many problems of low food production, supply, and availability, which have periodically resulted in famines, particularly in remote parts of the country (Khattab and Mahgoub, 1987). Foods of animal origin in the Sudan are normally produced by nomadic people, who move yearly for hundreds of miles in search of grass and water. This type of life makes it difficult for the nomads to get enough animal care and to acquire skills in animal production. This system results in low production. Fisheries in the Sudan are also faced with low production and inefficient transportation and marketing systems (Khattab and Mahgoub, 1987).

The problems of low food production in the Sudan have affected economic, social, and developmental conditions. Food supplies have become scarce and prices have increased over the past few years. Due to the influx of migrants to the big cities, especially Khartoum, food shares allotted to the original residents have declined. Inadequate food intake has the potential to affect the nutritional status of the city's population, and hence their working and production abilities. An additional problem faced in large cities such as Khartoum is that the foods which migrants were accustomed to in their home

area are not always available in the city. For example, Sudanese migrant's from millet consuming areas who come into Khartoum, where wheat is the staple food, still prefer to eat millet-based food rather than wheat bread. However, millet may be more expensive, and migrants may have to spend a large amount of their income to purchase it. This adversely affects the amount purchased and eaten, resulting in low food intake, low nutrient intake, and hence low nutritional and health status (Khattab and Mahgoub, 1987). Faced with the high price of traditional staple grains, low-income migrant families may replace their traditional grains with relatively cheaper grains found in the market. This often results in a dramatic change in the food intake of household members, and has the potential to change nutrient intake.

The population in the Sudan is composed of various distinct ethnic groups, each having its own customs and traditions, with marked differences in food behavior. For example, in a study done in the Gezira area in central Sudan to determine the dietary customs in selected villages, it was found that dietary patterns varied according to local customs and traditions, and were influenced by lack of education about nutritious foods, the low-income of families, poor transportation, and poor food availability (Zumrawi, 1988).

A food consumption survey was recently carried out in some areas of Khartoum, the capital of the Sudan (Khattab, 1991). Six different groups were surveyed. Three groups were displaced people from Northern Kordofan, the Nuba Mountains, and the Southern region. The other three groups were local low-income, medium-income, and high-income groups. Quantities of food consumed were converted into kilocalories and nutrients. Kilocalories and nutrients consumed per capita per day for each of the six groups were then

obtained by dividing the total intake by the number of individuals in the sample. Results showed that, with the exception of the displaced groups from the Southern region, the diets consumed by all other groups provide enough kilocalories (average of 2,235 kcal. per day) to meet their requirements, and in all cases these kilocalories were largely supplied by cereals (57.5% of kcal.). The average amount of kilocalories from protein consumed by all groups was more than adequate (13%), although most of it was derived from cereals. Foods of animal origin and pulses contributed about 25% to total protein intake. However, although the quantity of protein intake was sufficient, the quality of that protein may be low. This may not meet the protein requirements for normal growth for children.

The mean calcium intake of all groups was lower than recommended (350 mg). Such a dietary deficiency may result in retarded growth and other problems associated with calcium deficiency (osteoporosis in adults), particularly among vulnerable groups (Khattab, 1991). The mean iron intake was either adequate or more than recommended (23.24 mg). However, it must be noted that iron requirements are high during growth and pregnancy. With regard to the vitamins, it was found that foods that contain thiamine and niacin were consumed in adequate amounts, while riboflavin intake was generally lower than recommended due to the low consumption of milk and milk products. Ascorbic acid (vitamin C) consumption was adequate in the diets of all groups due to high consumption of fruits and vegetables. Vitamin A intake by all groups was much lower than recommended, which may contribute to vitamin A deficiency problems (Khattab, 1991). It was noted that this food consumption survey was carried out during the winter season (January–February), when both

plant and animal protein are generally abundant, and food prices are generally low compared with the summer season (May–August), when food is less available and more expensive.

Health status

Health, as stated in the Declaration of Alma Ata, is a "state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right, and that the attainment of the highest possible level of health is a most important worldwide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector" (World Health Organization, 1978). Many of the factors that influence the health status of individuals are related to their physical environment and living conditions. The physical environment greatly contributes to the general health conditions existing within a community and reflects the general health status of that community (i.e., mental, emotional, social, and physical health) (Anderson, 1969). The health of a family is often linked to the physical environment provided by the house, the services and facilities it contains, and its surroundings. Health is linked with a sufficient and safe domestic water supply, safe food storage practices, adequate washing and personal hygiene, and hygienic disposal of human waste. The area where the house is located is also important to health. For example, if children play outside the house, they may get diarrhea through ingesting pathogens from the fecal contaminated soils on which they play. A high incidence of respiratory diseases may result from smokey fires or stoves within improperly ventilated houses. Also, a high incidence of burns and scalds may be largely the result of small,

overcrowded homes in which occupants cook on open fires or unguarded stoves (Hardoy et al., 1990).

In addition to the impact of the housing and living environment on the health of the family, there are socio-economic characteristics that influence health. These characteristics include income, type of work, age, and gender. Other factors affecting health include diet, knowledge of appropriate health practices, time available to family members for health-promoting activities, and the availability and utilization of health care services (Hardoy et al., 1990).

Most research into health problems, to date, has been conducted by health professionals. Research has focused primarily on the incidence of diseases or their biological processes more than on early prevention procedures and cultural and environmental factors that cause diseases, such as community water supply, sanitation, and nutrition. For example, the use of oral rehydration therapy (ORT) has greatly improved the treatment of diarrhea. However, the prevalence of diarrhea is endemic due to lack of attention to diarrhea prevention, such as the ingestion of contaminated water and lack of facilities for personal hygiene.

Diarrheal disease is a major contributing factor to infant and child deaths, especially in the developing countries. It is also a precursor to many childhood illnesses and childhood malnutrition (Galway et al., 1987). In the developing countries, diarrhea contributes to one-fourth to one-third of the deaths among children under five years of age. An estimated five million children die from diarrhea every year (Galway et al., 1987).

In a national survey done in six regions in the Sudan in 1987, 21% of all children surveyed (18,000, ages 1–5 years) had diarrhea on the day of the survey. The prevalence of diarrhea varied between provinces, and was much higher

than expected in Blue Nile, White Nile, and South Darfur. The prevalence of diarrhea was highest among children under 27 months old (Department of Nutrition and Department of Health, 1987). In another study done to determine the effects of infection on growth in Sudanese children, 439 infants from a poor district of Khartoum were examined at intervals of two weeks from birth to one year of age. Symptoms suggesting infection (i.e., diarrhea, fever, vomiting, and cough or cold) were recorded. It was found that an average of 30% of the children had episodes of diarrhea and 40% had episodes of cold or cough in each four week period. The average duration of an episode was five days. When average weight gain was calculated, diarrhea produced a deficit in weight gain of 32 g per day ill, and cough/cold a deficit of 16.4 g per day ill. When the overall impact of illness on weight gain was calculated, a reduction of 160 g resulted when children had diarrhea for 12–24 days. A reduction of 95 g was produced in children having cough/cold for the same length of time (Zumrawi et al., 1987).

One of the health risk factors most affecting children in developing countries is immunization against the vaccine-preventable diseases (i.e., measles, diphtheria, pertussis, tetanus, poliomyelitis, and tuberculosis). Widespread immunization in the developed countries has virtually eliminated these diseases. Greater effort is taking place in many developing countries. In 1985, it was estimated that vaccination had prevented nearly a million child deaths. However, an estimated 3.5 million infants and children continue to die every year from vaccine-preventable diseases and their complications. An equal number are left blind, crippled, or mentally retarded (Galway et al., 1987).

In the Sudan, the health authorities have turned their attention to the prevalence of vaccine-preventable diseases. Some 50,000 Sudanese children are

believed to die needlessly each year from these diseases. During the worst of the 1984-85 famine, the number of children who were weakened by hunger and died as a result of vaccine-preventable diseases was estimated to be approximately 300,000 (United Nations Children's Fund, 1987). Although the Sudan started an expanded vaccination program in 1976, coverage consistently lagged far behind need. Lack of promotion was found to lay at the heart of the low coverage problem. Surveys done in Khartoum province in 1985 showed that 47% of parents surveyed did not know that vaccination was available, while another 27% knew about it but did not realize the importance of having their children immunized. Starting in 1985, an intensive immunization program was organized aimed at immunizing all Sudanese children by the year 2000. By 1986, 52% of the 71,000 children under one year in Khartoum area had been immunized, and 82% of them had received at least the first of the three doses against polio, diphtheria, whooping cough, and tetanus. Evaluation results showed that 82% of parents knew that vaccination was both available and important. If the program's goal is achieved, over one million children under one year of age will be immunized (United Nations Children's Fund, 1987). According to a recent report by the Ministry of Health (1991), around 80% of children in Khartoum had been immunized by the end of 1990, while the figure is around 50% in other regions.

Anthropometric characteristics

Nutritional anthropometry is concerned with the measurement of the variations in the physical dimensions and proportions of the human body at different age levels to indirectly detect degrees of nutritional status (Darwish and

Hussein, 1985). The methods and the measurements used in anthropometry can vary greatly in number and complexity. Their selection depends on the purpose and objectives of each particular survey or study (Darwish and Hussein, 1985).

Anthropometry is the most commonly used indirect method for the assessment of two of the most widespread nutrition problems in the world: protein-energy malnutrition (PEM), especially among young children, and obesity in all age groups. It is also commonly used to monitor growth during childhood and pregnancy, as well as pathophysiological alterations of body dimensions in the elderly (Jelliffe et al., 1989). Nutritional anthropometry has the advantages of being objective, a relatively inexpensive way to obtain data, and understandable by both professionals and the public. It is most useful when assessing young children in whom growth should be rapid and many of whom are at risk of having PEM (Jelliffe et al., 1989).

The basic anthropometric measurements for school children, as with other age groups, are weight and height. The arm circumference may also be useful in situations of emergency screening and, together with triceps fat fold, can help assess relative stores of protein and energy (Jelliffe et al., 1989).

In order to interpret weight and height measurements, standardized reference data are needed. Reference values based on studies of American children are most commonly used in both developed and developing countries. The World Health Organization (WHO) has published reference standards from data on American children suitable for developing countries. When used in developing countries, the cut-off points for abnormally low weight-for-height ('wasted') or height-for-age ('stunted') are approximately the 3rd centile or –2 standard deviations (SD) below the median. Waterlow et al. (1977) recommend

that for the assessment of nutritional status of children in cross-sectional studies primary reliance should be placed on weight-for-height as an indicator of present nutritional status and on height-for-age as an indicator of past nutritional status (Waterlow et al., 1977).

In developing countries, it is often difficult to obtain accurate information on the age of school children either from school records or from parents. However, determining age to the nearest year is important for interpreting height and weight measurements relative to age. Weight-for-height has the advantage of being independent of knowledge of age. However, weight-for-height is not a particularly sensitive nutritional indicator in adolescence when there is a marked increase in growth velocity (Pollitt, 1990; Frisancho, 1990). In addition, weight-for-height does not detect children who are proportionally stunted.

Using standardized data as a reference, one can determine the extent to which school-aged children are growing either normally, advanced, or delayed for their age. Several studies are reported to indicate the growth of school-aged children in developing countries. For example, in a study of Panamanian children in 1987, Parillon et al. (reported in Jelliffe et al., 1989) found that height was an especially useful measure that reflected not only inherent genetic factors, but also prior environmental influences on growth. Height-for-age of seven year old primary school children was positively and significantly correlated with indices of general socio-economic development. Other studies from developing countries that report height and weight measurements present a general picture of the growth status of low-income school children. Most of these studies used WHO reference standards. In a study reported by Agarwal et al. in 1987 (in

Pollitt, 1990), it was found that only 13.5% of a low-income, primary school sample in Uttar Pradesh, India, had heights and weights which were normal for their age. Some 84% had deficits in weight, and 57% had deficits in height.

In 1987, Florencio (in Pollitt, 1990) examined school children in grades one to four in four public schools in five regions in the Philippines. Using weight-for-age standards, out of 2,240 children, 19.4% were moderately under-weight and 1.2% were severely under-weight. Approximately 8% were moderately under-weight for their height.

In Kenya, Sigman et al. (in Pollitt, 1990) conducted a study to determine the relationship between nutritional status variables, family characteristics, and education in the Embu District, 120 miles northeast of Nairobi. A sample of 138 children with a mean age of 7.5 years were measured. It was found that approximately 25% of the sample were stunted, and about 40% were wasted. From the results of this and the other studies mentioned above, the prevalence of growth retardation among low-income school-aged children is striking. These findings suggest that low-income school-aged children are at high nutritional risk.

A study done as part of a national nutritional survey in Kuwait in 1985 compared the nutritional status of Kuwait children aged six to nine years with the American reference population. A sample of 5,132 primary school children were surveyed, and heights and weights were obtained. Subjects were selected from both low and high socio-economic districts. The basic indices used for comparison were height-for-age, weight-for-age, and weight-for-height. Results indicated that among the children surveyed in the low socio-economic districts, 11.5% fell below –2 SD of the American reference population median (under-

weight), while only 1.5% from the high socio-economic districts were in this low range. Weight-for-height measurements indicated that 4.0% fell below –2 SD of the reference population median (wasted) in low socio-economic districts (Bayoumi and Moussa, 1985).

In another study done in Kuwait to construct standards for growth for primary school children six to nine years old, anthropometric measurements were taken. A sample of 6,765 children were examined. Anthropometric data were converted into percentiles for weight-for-age, height-for-age, and weight-for-height. A comparison between these locally constructed standards and western reference growth standards revealed marked similarities in attainable growth (Bayoumi et al., 1984). The relatively good growth status of these Kuwaiti children might be due to the fact that Kuwait, at the time of the study, was considered to be a rich country with a relatively high standard of living due to its large oil resources.

In the Sudan, a few unpublished studies are available reporting anthropometric data of school-age children. A study was carried out by Bushara in 1967 in a low socio-economic housing area of El Hag Yousif, Khartoum North, on 170 primary school children ages seven to 14. Weight-for-height measurements indicated that 93% were below –2 SD of the WHO reference population median (wasted). Other related problems reported were PEM, anemia, and low caloric intake (Bushara, 1973).

In 1979, anthropometric measurements, mainly height and weight, were taken for 150 fourth grade students attending a primary school in Hai Elarab, a low socio-economic housing area in Omdurman. It was found that 7% of the sample was below –2 SD of the WHO reference population median (stunted)

when height-for-age measurements were taken. Weight-for-height measurements indicated that 97% were below -2 SD of the WHO reference population median (wasted). Other reported problems were tonsillitis, dental caries, low hemoglobin levels, and low caloric intake (Agieb, 1988).

Methodology

Data collection

To provide information on the food behavior patterns of the children's families, the mothers or female guardians were asked questions regarding the type of cooking area they had at home, types of cooking fuel used, amount of money the household spent for food daily, the source (home produced, market, or vendor) of 11 common foods, and who usually shopped for food at the market. Regarding the children's eating behavior and patterns, mothers or female guardians were asked questions about the number of meals and snacks the child ate per day, whether or not the child ate breakfast and/or snacks while at school, and, if so, where he/she obtained the breakfast and/or snack. In addition, the interviewee was asked questions about the child's midday meal at home--when it was eaten, how the child's food was obtained, and whether or not the mother sat with the child while he/she ate. Questions were also asked on how often the child ate 13 types of food, including foods from all major food groups. Next, the child's food intake pattern was obtained through a previous day's food recall of the types of food eaten by the child and the times they were eaten. The mother or female guardian was finally asked her opinion of the amount of food eaten by the child (too much, too little, about right), whether or

not she would like to see the child eat more food, and, if so, what type of food she would like him/her to eat more of.

Information on health status was obtained by asking the mothers or female guardians whether or not the child had had ten common diseases or illnesses during the present school year. They were also asked whether or not each disease or illness had caused the child to be absent from school.

Finally, height and weight were obtained by the researcher using standard anthropometric procedures for measuring school-aged children (Jelliffe et al., 1989). Body weight, without shoes and in school uniform, was measured to the nearest 0.5 kg using a beam balance scale. Height without shoes was measured using a UNICEF height anthropometer designed for measuring heights of school children. The anthropometer consists of a measuring tape attached to a movable plastic triangle. The measuring tape is stretched to its maximum and placed on a flat wall. After standing the child with his/her back to the wall and head in the normal carrying position, the plastic triangle is brought down perpendicular to the wall and parallel the top of the child's head. Height was recorded to the nearest 0.5 cm by directly reading from the tape.

Data analysis

Prior to data analysis, the heights and weights of the children were converted into percentiles using the World Health Organization (1983) tables: weight (kg) by age of boys aged 2-18 years, weight (kg) by age of girls aged 2-18 years, stature (cm) by age of boys aged 2-18 years, stature (cm) by age of girls aged 2-18 years, weight (kg) by stature of boys 55-145 cm in height, and weight (kg) by stature of girls 55-137 cm in height. The birth date of each child was used to

calculate the actual age in years and months. The weight in kg and the age in years and months were used to determine the weight-for-age percentile for the child. Similar to weight for age, the stature in cm of each child and his/her age in years and months were used to determine the stature-for-age percentile. The stature in cm and weight in kg for each child were used to determine the weight for stature percentiles of the children (World Health Organization, 1983).

Frequencies and percentages were computed for all variables. In addition, scores were computed for two sets of variables to assist in statistical analysis. First, for the information indicating the source (home produced, market, and/or vendor) of 11 types of common foods used by each household, a score was computed for each of the three food sources to indicate how many of the 11 foods were obtained from each source (potential range of 0-11). Second, a health score was computed to indicate how many of ten common diseases or illnesses the child had had during the present school year (potential range 0-10).

Spearman correlation coefficients, t-tests, and chi-square values were calculated to determine the interrelationships between various food behavior patterns, health status variables, anthropometric characteristics, and demographic variables. Interrelationships between selected variables were also examined using analysis of variance and post-hoc t-tests.

Results and Discussion

Food-related characteristics of the families

Selected characteristics of the families' food environment and food behavior are presented in Table 7. Over half of the sample had kitchens built separate from inside the house (52.5%). These types of kitchens were typically

Table 7. Selected characteristics of the families' food environment and food behavior (n=198)

Characteristic	Frequency	Percent
Cooking area used by household[a]		
Kitchen built separate from inside house	104	52.5
Open veranda	41	20.7
Kitchen as room inside house	34	17.2
Open space outdoors	20	10.1
Type of cooking fuel[a]		
Charcoal	195	98.5
Wood	83	41.9
Gas	80	40.4
Kerosene	22	11.1
Electrical cooker	11	5.6
Money spent daily for food		
Less than 100 pounds	23	11.6
100-200 pounds	73	36.9
201-300 pounds	74	37.4
301-400 pounds	23	11.6
401-500 pounds	5	2.5
Person in household who usually shops for food[a]		
Self	146	73.7
Husband	132	66.7
Son	73	36.9
Other	32	16.2

[a]Multiple responses possible

small rooms with small windows and no ventilation. About 21% of the families were using an open veranda as the cooking area, while only 17.2% had a room inside the house that was used as a kitchen. The remaining 10.1% cooked in an open space outdoors. Almost all of the subjects' families used charcoal as a fuel for cooking (98.5%). Wood was used by 41.9% of the families and gas by 40.4%. Kerosene and electricity were used by few families. The widespread use of charcoal and charcoal stoves among low socio-economic families create a fire hazard because this type of stove stays lit for most of the day. This cooking situation is especially a problem for small children who play near cooking areas where the risk of burns is high. Hardoy et al. (1990) reported that the causes of fire in low socioeconomic settlements include upset cooking stoves, spilled gasoline or kerosene, and leaking gas cylinders. Vulnerability to fire is extremely high in settlements constructed of flammable material, where uncollected waste material may be piled in open areas or burnt for clearance, and where settlements are constructed with no consideration for the overall capacity and layout of the site. These characteristics were typical of the housing areas used for this study.

The majority of the sample spent from 101 to 300 Sudanese pounds for food daily (74.3%). About 11.6% spent less than 100 pounds and only 14.1% spent more than 300 pounds for food per day. For the majority of the sample, the parents normally shopped for food. With the high inflation rate and the current economic crisis in the Sudan, the poorer groups suffer from reduced purchasing power, including their capacity to pay for food and improved housing and services. Hardoy et al. (1990) reported that during the 1980s average incomes fell over 20% in Sub-Saharan Africa, and in many urban areas real minimum wages

declined as much as 50%. Moreover, malnutrition is increasing, which means that lower income groups are more vulnerable to diseases. Lower incomes for the workforce can mean poorer quality diets for some of their children, who then become more vulnerable to diseases. Therefore, deaths from diseases such as diarrhea or measles are more likely.

Several indirect measures of socio-economic status were related to the type of kitchen each family had and the cooking fuel used. For example, families with fathers who had a lower level of education were more likely to use an open veranda as a kitchen (x^2=12.79, df=5, p=.030). Having a kitchen as a room inside the house or as a room separate from inside the house was significantly related to a higher wealth score, as computed in the previous chapter (p=.026 and p=.005, respectively). On the other hand, having an open space outdoors or an open veranda as a cooking area was significantly related to a lower wealth score (p=.036 and p=.000, respectively). Those families who had flush toilets were also likely to have a kitchen as a room inside the house (x^2=10.48, df=1, p=.001). Families headed by fathers with low educational achievement were more likely to use wood as a cooking fuel (x^2=11.91, df=3, p=.007). In contrast, families headed by fathers with higher educational attainment were more likely to use gas as a cooking fuel (x^2=15.78, df=3, p=.001). Similar relationships were found for the type of cooking fuel used and the occupational status of the fathers. More families with fathers who were laborers were using wood (x^2=12.33, df=3, p=.006), while families in which the fathers were government officers or owned small businesses tended to use gas more as a cooking fuel (x^2=13.50, df=3, p=.004).

Cairncross (1990) reported that in about two-thirds of all Third World nations, the poor make up the majority of the population as a result of their lack

of income, capital resources, and productive land. This means that they use virtually all of their resources on daily necessities, especially food, and have very limited capacity to pay for other basic services. The money spent daily for food by families in this study may have consumed most of their income. The money the family spent daily on food was positively correlated with the father's educational achievement (r=.339, p=.000) and the wealth score (r=.482, p=.000). Furthermore, families of fathers with better paying jobs, such as government officers and small business owners, tended to spend more money on food (x^2=50.17, df=12, p=.000). In the Omdurman, area families tended to spend less per day for food than in Khartoum North or Khartoum (x^2=19.57, df=8, p=.012).

Sources of selected foods used in the households are presented in Table 8. Foods are classified according to whether they were produced at home, bought from the market, and/or bought from a vendor. Only about 27% of the families reported producing milk at home. However, most of the families who raised goats reported producing milk at home (83.1%). The majority of families bought milk at the market, and only 34.3% bought milk from vendors. Yogurt and butter were most likely to be purchased from the market. Similarly, bread was most likely to be bought at the market since it was rationed. Few families made wheat bread or grassa from wheat flour at home or bought supplemental bread from nearby vendors. Kissera (a major local food made out of sorghum) was produced at home by the majority of the families (77.3%). Raw sorghum was bought from the market by almost all families, washed, dried, milled into flour, and fermented for kissera making. Millet is widely used in the western region of the Sudan. Families who used millet in the capital area bought it mainly at the market (64.6%) and made it into porridge. Almost all families bought lentils and

Table 8. Sources of selected foods used in the households (n=198)

Food	Home produced		Bought from market		Bought from vendor	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Milk	54	27.3	138	69.7	68	34.3
Yogurt	11	5.6	154	77.8	2	1.0
Butter	1	0.5	128	64.6	1	0.5
Wheat, bread or grassa	5	2.5	189	95.5	5	2.5
Sorghum or kissera	153	77.3	195	98.5	1	0.5
Millet	2	1.0	128	64.6	0	0.0
Lentils and beans	2	1.0	193	97.5	0	0.0
Chicken	53	26.8	143	72.2	1	0.5
Meat	20	10.1	195	98.5	0	0.0
Fruits	1	0.5	181	91.4	0	0.0
Vegetables	3	1.5	197	99.5	26	13.1

beans, and were likely to buy them in the market place (97.5%). Broad beans are widely used by families in the Sudan, especially in urban areas for breakfast and supper meals. About one-fourth of the families produced chickens at home and about three-fourths bought them at market. About 10% of families reported producing meat at home, with around one-third of the families who raised goats reporting producing meat at home. Most families purchased meat at the market (98.5%). Fruits and vegetables were mostly bought at the market, and about 13.1% bought vegetables from vendors in addition to the market.

The home production, market, and vendor purchasing scores explained in the data analysis section of this chapter were computed. The home production score ranged from 0 to 5 indicating that no family produced over five of the 11

food items at home, with 45.5% producing only one food item at home. The number of the 11 food items that were purchased at the market ranged from 4 to 11, with a little under one-third of the families purchasing all 11 food items at market. The majority of the families did not purchase any of the 11 food items from vendors (60.6%), and those who purchased from vendors bought a maximum of two items from vendors. This outcome may be explained by the fact that food prices are high in the Sudan, and vendors usually purchase their food from the market and resell it at even higher prices to people in their local areas. Khattab and Mahgoub (1987) reported that the food problems in the Sudan cannot be solved unless all aspects of food receive deserved attention, and all efforts are directed to one goal, which is making available within easy access low-cost nutritious food to the population. Furthermore, they concluded that the general food problems in Africa, and especially in urban areas, are complicated by demographic factors, increased number of people who do not produce food and depend on food supplies provided to the urban areas, low incomes, and the influence of changing food expenditure patterns.

Many statistical relationships were investigated between sources of selected foods used in the households and demographic characteristics. The educational achievement of fathers was positively correlated with the number of foods purchased at market ($r=.138$, $p=.029$) and was negatively correlated with the number of foods produced at home ($r=-.175$, $p=.008$), with families headed by fathers with lower educational achievement purchasing less foods at market and producing more food items at home. A larger household size was related to an increase in the number of food items produced at home ($r=.158$, $p=.013$) and a

decrease in the number of food items purchased from the market (r=-.128, p=.036).

Similarly, families headed by fathers who were government officers or owned small businesses tended to buy more food items from the market (x^2=13.00, df=6, p=.043) than families headed by fathers who were laborers or self-employed. This finding is consistent with Khattab and Mahgoub's (1987) report of studies in some Western African countries (i.e., Ghana and Nigeria) which revealed that, within a given income bracket, an increase in household size tends to decrease the food outlay per person, and therefore, reduces the chances of meeting the food and nutritional needs of the individuals.

Families with high wealth scores tended to possess high market purchasing power (r=.362, p=.000) and low home producing power (r=-.136, p=.028). The more money spent for food per day, the more food items the family reported purchasing from the market (r=.321, p=.000) and the fewer the number of food items produced at home (r=-.142, p=.023). Finally, those who lived in Khartoum or Khartoum North were likely to buy more food items from the market (x^2=15.29, df=4, p=.004) than those who lived in Omdurman area, who were likely to buy more food items from vendors (x^2=93.79, df=4, p=.000). In general, vendor services seemed to be more popular in the Omdurman area than in Khartoum and Khartoum North.

Food-related characteristics of the children

Selected characteristics of the children's food behavior are presented in Table 9. The majority of the sample ate three meals daily (97.5%). All of the children ate breakfast at school, with the majority taking their breakfast food

Table 9. Selected characteristics of the children's food behavior

Characteristic	Frequency	Percent
Number of meals eaten daily		
2	5	2.5
3	193	97.5
Child eats breakfast at school		
Yes	198	100.0
No	0	0.0
Source of child's breakfast food (n=198)[a]		
Take from home	149	75.3
Buy from food shop inside school	75	37.9
Buy from food shop outside school	21	10.6
Buy from school vendor	13	6.6
Child eats a snack at school		
Yes	145	73.2
No	53	26.8
Source of child's snack food (n=145)[a]		
Buy from school vendor	82	56.6
Take from home	58	40.0
Buy from food shop	14	9.7
Other	11	7.6

[a]Multiple responses possible

from home (75.3%). Many children also bought breakfast food from the school's food shops, but only a few bought their food from shops outside school or from school vendors. Five of the six schools in the study did not allow children to leave school during the breakfast period, thus those children who did not buy breakfast from the school's food shops or school vendors had to bring their breakfast with them to school or have someone from home bring it to them at the breakfast break. Eating breakfast at school was reported by Parker (1989) to be very important for children's school performance, as demonstrated by results of studies carried out in carefully controlled laboratory settings. These studies suggest that skipping breakfast negatively affects children's performance in problem-solving situations similar to the ones they face in the classroom setting.

Approximately three-quarters of the sample ate snacks at school. In contrast to breakfast, the majority of those who ate snacks bought them from vendors (56.5%). The other snacks were either taken from home or bought from food shops.

The midday meal in the Sudan is the largest and major meal that the family normally eats. It is eaten in the afternoon when family members return from school or work. About 47.0% of the sample ate their midday meal immediately after they came home from school. The rest of the children waited and ate later with their families. Furthermore, 69.5% of those who ate later with the family had a portion of the meal saved or reserved specifically for them, while the rest of the children usually ate leftovers from the family meal. The majority of mothers (61.6%) always sat with the child while he/she ate his/her midday meal, and about 26.8% reported sometimes sitting with the child. Only 11.6% of the children ate the midday meal without their mother's attendance.

Four significant relationships were found between the children's snacking behavior and other variables. More children attending the Khartoum schools ate snacks at school than those attending schools in Omdurman and Khartoum North (x^2=15.59, df=5, p=.008). The daily money spent by the household on food was also significantly related to the child's school snacking behavior. The children whose families spent over 200 pounds for food daily were more likely to eat snacks at school than those whose families spent less (x^2=17.26, df=4, p=.001). Children who bought snacks from vendors were not likely to take snacks from home (X^2=77.84, df=1, p=.000). Also, children who ate snacks at school were more likely to wait and eat their midday meal later with the family than those who did not eat snacks at school, who were more likely to eat their midday meal immediately after they came home from school (x^2=10.56, df=1, p=.001). A significant relationship was found between the time the child ate his/her midday meal and his/her school. Children attending school in Khartoum were more likely to eat their midday meal later with the family than children attending school in Omdurman or Khartoum North (x^2=15.99, df=5, p=.007). This may be due to the fact that more children in the Khartoum area ate snacks at school compared to children in Khartoum North and Omdurman. Other significant relationships between midday meal variables and other variables were not found.

The children's frequency of intake of 13 selected foods or types of food is presented in Table 10. The first type of foods in Table 10, milk, cheese, and yogurt, is the best source of calcium in the Sudanese diet. Almost three-quarters of the sample had a dairy product every day, while 7.6% reportedly seldom or never ate dairy products.

Table 10. The children's frequency of intake of 13 selected foods or types of food (n=198)

Food	Percent of children				
	Every day	About every other day	At least once per week	At least once per month	Seldom or never
Milk, cheese, or yogurt	74.7	12.6	4.5	0.5	7.6
Bread	98.5	1.5	0.0	0.0	0.0
Grassa, kissera, or porridge (sorghum or millet)	37.4	34.8	15.2	3.0	9.6
Rice	1.5	27.3	47.0	18.2	6.1
Meat like goat, beef, fish, or chicken	63.6	26.3	8.1	1.5	0.5
Eggs	7.1	44.4	31.3	8.1	9.1
Dried beans	37.9	27.8	26.3	7.1	1.0
Green vegetables like molokhya, regla, and okra	7.1	28.8	60.6	1.5	2.0
Yellow vegetables like sweet potatoes, squash, pumpkin, and carrots	1.5	26.8	62.6	4.5	4.5
Other vegetables like potatoes	1.0	30.3	64.1	2.0	2.5
Fresh fruit or fruit juice like watermelon, oranges, and bananas	7.6	18.7	39.4	22.7	11.6
Nuts and seeds	54.5	30.8	6.6	1.5	6.6
Sweets like cookies, soft drinks, candy, sugar cane, and dates	33.8	38.4	15.7	5.6	6.6

The next three items in Table 10 represent frequently eaten Sudanese cereal-based foods. Wheat bread was the most frequently consumed food on the list, consistent with the results of a food consumption survey done in the capital in which cereals, especially bread, contributed 63% of a group of low income familie's calories per day (Khattab, 1990). Sorghum and millet in the form of grassa, kissera, or porridge were consumed either daily or every other day by two-thirds of the sample, also contributing to the high percentage of calories provided by cereals in the diet of low income people, as mentioned above. Rice was not a frequently eaten cereal in the diets of these children. Only about 29% of the sample ate rice daily or about every other day. Approximately one-half of the sample ate rice once per week.

Three items in Table 10 represent good sources of protein, heme iron (meat), and vitamin A (eggs). Meats were frequently eaten by these children. About two-thirds ate meats every day and another one-fourth about every other day. However, the portion of meat eaten by the child might have been small since an average of one pound of meat is usually cut into small pieces and made into a stew with vegetables and served for the whole family. The food consumption report cited earlier (Khattab, 1990) reported that meats contributed only about 7% of the calories in the diets of low income people. Eggs were consumed either daily or about every other day by about one-half of the sample. Dried beans were consumed by the majority of the sample either daily or every other day (65.7%). Khattab (1990) reported that pulses contributed about 4% of the calories in low income families' diets in the Khartoum area.

The children had similar consumption patterns for the three categories of vegetables in Table 10--green vegetables, yellow vegetables, and other vegetables.

Most children reportedly consumed these vegetables at least once per week. Only a little over one-quarter to one-third consumed these vegetables daily or every other day. Green and yellow vegetables are good sources of carotene. The children's intake of vegetables is consistent with the patterns of cooking of Sudanese families, in which the main dish of the midday meal is often a stew with vegetables. Mothers tend to use different vegetables each day, if possible. Khattab (1990) reported a contribution of 6% of calories in the diets of low-income families from vegetables. In contrast to vegetables, fruits were likely to be consumed less often by the sample. Only 7.6% of the children reportedly ate fruits or fruit juice every day, and less than one-fifth every other day. The majority of the children ate fruits or fruit juice at least once per week or once per month. This low frequency may be due to relatively high prices of fruits, seasonality, or both. However, this survey was undertaken during the winter, which is considered the best season for having fresh fruits in the markets of the capital.

Two types of foods eaten primarily as snacks are the last two items in Table 10. Nuts and seeds were consumed by over one-half of the sample daily and by about 31% about every other day. Nuts and seeds,such as watermelon seed and peanuts, are commonly sold as snacks by vendors near schools. Sweets like cookies, soft drinks, candy, sugar cane, and dates were consumed by over two-thirds of the sample every day or about every other day. Khattab (1990) reported a contribution of about 5% of calories from sugar and honey in the diets of low-income families in the Khartoum area.

The frequency of intake of each food or type of food was statistically tested against some of the demographic and living environment characteristics to

determine interrelationships between variables (Table 11). In general, consumption of rice, meat, eggs, and fruits were related to both father's educational achievement and father's occupation. Children with fathers who had higher levels of education or who were government officers or owned small businesses consumed those products more frequently than children with fathers who were laborers or self-employed. The fact that these were the most expensive foods on the list may have made them more affordable by those families with fathers who had higher paying jobs. Dried beans especially broad beans were popular in the diet of low-socioeconomic groups. However, their increased prices made them unaffordable by fathers with low paying occupations. On the other hand, sorghum and/or millet were the only food items that were consumed more frequently by children of fathers with lower educational achievement. Children in the Omdurman area less frequently consumed bread, rice, meat, and nuts and seeds. Milk and milk products, rice, meat, eggs, other vegetables, fresh fruits, and sweets were positively correlated with daily money spent on food, indicating that children whose families spent more money on food per day were most likely to consume those foods frequently.

It is interesting that male children more frequently consumed milk and milk products and fresh fruits than female children. On the other hand, female children more frequently consumed green vegetables than male children. Consumption of rice, meat, and sweets was negatively correlated with the age of the children. Older children tend to consume these three food items or food types less frequently than younger children. Furthermore, consumption of dried beans and green vegetables was more frequent among children in higher grades. Size of the family was negatively correlated with frequency of consumption of

Table 11. Statistical relationships between selected food intake frequencies and demographic variables

Food item or group	Father's education	Father's occupation	Area	Daily money spent on food	Sex	Age in months	Grade in school	Number of people in household
Milk, cheese, or yogurt	NS[a]	NS	NS	r=.1281 p=.036	t=2.67 p=.008	NS	NS	r=-.1629 p=.011
Bread	NS	NS	F=3.095 df=2, 195 p=.047	NS	NS	NS	NS	NS
Grassa, kissera, or porridge (sorghum or millet)	r=-.3029 p=.000	NS	NS	NS	NS	NS	NS	r=.1361 p=.028
Rice	r=.2705 p=.000	F=7.626 df=3, 176 p=.000	F=4.60 df=2, 195 p=.011	r=.3516 p=.000	NS	r=-.1387 p=.026	NS	NS
Meat like goat, beef, fish, or chicken	r=.2332 p=.000	F=6.936 df=3, 176 p=.000	F=7.949 df=2, 195 p=.000	r=.4382 p=.000	NS	r=-.1793 p=.003	NS	NS
Eggs	r=.2293 p=.001	F=2.963 df=3, 176 p=.034	NS	r=.2563 p=.000	NS	NS	NS	r=-.2001 p=.002
Dried beans	NS	F=2.760 df=3, 176 p=.044	NS	NS	NS	NS	r=.1330 p=.031	NS

[a]NS is not significant

Table 11. Continued

Food item or group	Father's education	Father's occupation	Area	Daily money spent on food	Sex	Age in months	Grade in school	Number of people in household
Green vegetables like molekhya, regla, and okra	NS	NS	NS	NS	t=2.67 p=.008	NS	r=.1635 p=.011	NS
Yellow vegetables like sweet potatoes, squash, pumpkin, and carrots	NS	NS	NS	NS	NS	NS	NS	NS
Other vegetables like potatoes	NS	NS	NS	r=.1398 p=.025	NS	NS	NS	NS
Fresh fruit or fruit juice like watermelon, oranges, and bananas	r=.3712 p=.000	F=8.692 df=3, 176 p=.000	NS	r=.4596 p=.000	t=-2.37 p=.019	NS	NS	r=-.1276 p=.037
Nuts and seeds	NS	NS	F=3.485 df=2, 195 p=.033	NS	NS	NS	NS	NS
Sweets like cookies, soft drinks, candy, sugar cane, and dates	NS	NS	NS	r=.2460 p=.000	NS	r=-.1590 p=.013	NS	NS

milk and milk products, eggs, and fresh fruits. Children from larger-sized families tend to consume these food products or items less frequently. Again, the relatively high prices of those products may have made it difficult for low socio-economic, larger families to obtain them frequently. Moreover, grassa, kissera, or porridge were more frequently consumed by children from larger-sized households, as these products were more likely to be produced at home.

The frequency of consumption of certain food products which might be available to households as a result of raising domestic animals which could be a source of food products was investigated. Children whose families raised goats, compared to those whose families did not raise goats, were likely to more frequently consume milk and milk products (p=.048). In contrast, the consumption of meat products was not significantly associated with raising chickens by the family and was actually lower for children whose families raised goats (p=.041). On the other hand, children whose families raised chickens were likely to eat eggs more frequently (p=.011).

Information from the previous day's food recall of children in this study describing the percentages of children who ate meals and snacks is presented in Table 12. The majority of the children ate three meals. A morning snack was eaten by over 90% of the sample, and about 70% ate a midday snack. Only a little over one-third of the sample ate an evening snack.

Only two significant relationships were found between the meals or snacks eaten by the children and the descriptive characteristics. Children whose fathers were government officers or owned small businesses were more likely to have eaten a midday snack than those whose fathers were laborers or self-employed (x^2=14.89, df=3, p=.002). This relationship may be due to the fact that

Table 12. Percentage of children eating meals and snacks on the previous day (n=198)

Name of meal/snack	Percentage of children eating meal/snack	
	Yes	No
Morning snack	91.9	8.1
Breakfast meal	98.5	1.5
Midday snack	70.2	29.8
Afternoon meal	99.0	1.0
Evening snack	36.4	63.6
Evening meal	72.2	27.8

the majority of the children who ate midday snacks bought them from vendors, thus the family had to be able to afford to give the child money for this snack. The few who did not eat breakfast were from families headed by fathers who had lower levels of education (p=.028).

Foods eaten by the children on the previous day are presented in Table 13. The typical morning snack of low socio-economic families in the Sudan consists of a cup of tea with milk and sugar and a piece of bread for each member of the family. Almost all of the children had tea with sugar, and about three-quarter also had milk in their tea. Only 51.6% had bread. Bread is rationed in the Sudan, and not many large-sized families have bread for the morning snack. The typical breakfast meal for the school children from low socio-economic families is a wheat bread sandwich consisting of cooked broad beans with some vegetable oil added. About 60% of the children in this study had eaten broad bean sandwiches for breakfast for the previous day. The food shops at schools typically sold these

Table 13. Foods eaten by children for each meal and snack on the previous day

Name of meal/snack	Food	Children eating	
		Frequency	Percent
Morning snack (n=182)	Sweets or sugar	180	98.9
	Tea	177	97.3
	Milk	140	76.9
	Bread	94	51.6
	Grassa, kissera, or porridge	2	1.0
Breakfast meal (n=195)	Bread	185	94.9
	Vegetable oil	163	83.6
	Dried beans	117	60.0
	Salad (vegetable)	41	21.0
	Sweets or sugar	20	10.2
	Meat	14	7.2
	Green vegetables	11	5.6
	Eggs	9	4.6
	Grassa, kissera, or porridge	8	4.1
	Cheese	6	3.1
	Yellow vegetables	3	1.5
	Rice	2	1.0
Midday snack (n=139)	Bread	114	82.0
	Other vegetables	43	30.9
	Sweets or sugar	43	30.9
	Dried beans	28	20.1
	Vegetable oil	21	15.1
	Salad (vegetable)	12	8.6
	Green vegetables	11	7.9
	Grassa, kissera, or porridge	10	7.1
	Meat	10	7.1
	Yellow vegetables	10	7.1
	Milk	9	6.5
	Nuts and seeds	7	5.0
	Eggs	7	5.0
	Fruits and juice	6	4.3
	Tea	2	1.4
	Rice	1	0.7

Table 13. Continued

Name of meal/snack	Food	Children eating	
		Frequency	Percent
Afternoon meal (n=196)	Vegetable oil	182	92.9
	Meat	172	87.8
	Bread	156	79.6
	Green vegetables	94	47.9
	Salad (vegetables)	88	44.9
	Grassa, kissera, or porridge	49	25.0
	Yellow vegetables	46	23.5
	Dried beans	29	14.8
	Rice	28	14.3
	Other vegetables	27	13.8
	Sweets or sugar	2	1.0
	Fruits and juice	1	0.5
	Milk	1	0.5
Evening snack (n=72)	Sweets or sugar	60	83.3
	Bread	33	45.8
	Milk	32	44.4
	Tea	18	25.0
	Vegetable oil	14	19.4
	Fruits and juice	7	9.7
	Rice	5	6.9
	Grassa, kissera, or porridge	4	5.5
	Meat	4	5.5
	Dried beans	4	5.5
	Other vegetables	2	2.8
	Yellow vegetables	1	1.4
Evening meal (n=143)	Bread	110	76.9
	Sweets or sugar	72	50.3
	Vegetable oil	67	46.9
	Milk	61	42.7
	Dried beans	58	40.6
	Meat	16	11.2
	Grassa, kissera, or porridge	10	7.0
	Tea	9	6.3
	Green vegetables	8	5.6

Table 13. Continued

Name of meal/snack	Food	Children eating	
		Frequency	Percent
Evening meal (n=143) (continued)	Rice	8	5.6
	Salad (vegetable)	6	4.2
	Eggs	4	2.8
	Yellow vegetables	4	2.8
	Nuts and seeds	1	0.7
	Other vegetables	1	0.7

broad bean sandwiches. Children who brought their breakfast from home or bought it from shops outside the school or from the school vendor were likely to eat, in addition to broad bean sandwiches, a vegetable salad, sweets (jam or honey), minced meat sandwiches, cheese sandwiches, and/or egg sandwiches. The few children who ate grassa, kissera, or porridge for breakfast were likely to have eaten it with minced meat stew or meat stew containing green or yellow vegetables, and they were likely to have had breakfast at home. The majority of the children who ate a midday snack were likely to eat a piece of wheat bread (82.0%) with sweets such as jam and honey (30.9%), broad beans, or a salad. Other children snacked on the foods being cooked for the family's afternoon meal, such as a meat stew including green vegetables, other vegetables like potatoes, and yellow vegetables, with bread, kissera, or grassa. A few children ate nuts and seeds, eggs, fruits or fruit juice, tea, or rice for the midday snack.

The afternoon main meal for the family was eaten by almost all of the children. The typical afternoon meal for a low socio-economic family consists of

a vegetable stew with or without meat, a green salad, and bread and/or kissera. Among this sample, the majority of the families prepared this typical meal. A variety of vegetables was used, and vegetable oil was used by 92.9% of the families in their cooking. Rice was eaten by 14.3% of the children. Sweets, fruits, and milk were eaten by only a few children for the afternoon meal.

The 72 children who ate an evening snack were likely to drink a glass of milk with sugar, and sometimes tea (with sugar) and a piece of bread. Other children were likely to snack on foods left over from the afternoon main meal.

The evening meal was an important meal for many of these school children. This meal closely resembles the breakfast meal in terms of foods eaten. Many children ate sweets or broad bean sandwiches. About 40% ate bread and drank milk with sugar . Only a few ate leftovers from the afternoon meal for the evening meal.

The findings of the previous day's food intake recall are consistent with the results of the food consumption patterns recorded in a survey of a low income group in the Khartoum area (Khattab, 1990); it was reported that 63% of the calories came from cereals, 11% from vegetable oils, and 10% from foods of animal origin. The protein intake for this group was high, 86.5 gm per capita per day. However, two-thirds of the protein was of plant origin.

When asked about their satisfaction with the amount of food eaten by their children, approximately two-thirds of the mothers (62.6%) reported that their children were eating about the right amount and a third (34.3%) reported that their children ate too little. Only 3.0% reported that their children ate too much. Furthermore, a majority of the mothers (86.9%) reported that they would like to see their children eat more foods. Foods that mothers would like their

Table 14. Foods mother would like the child to eat more frequently (n=172)

Name of food	Frequency[a]	Percent
Milk	91	52.9
Meat	80	46.5
Fruits and juice	74	43.0
Sweets	60	34.9
Eggs	55	32.0
Vegetable oil	19	11.0
Rice	12	7.0
Dried beans	10	5.8
Green vegetables	4	2.3
Other vegetables	4	2.3
Salad (vegetable)	3	1.7
Bread	1	0.6
Grassa, kissera, porridge	1	0.6
Yellow vegetables	1	0.6

[a]Multiple responses possible.

children eat more of are listed in Table 14. Over one-half of the mothers would like their children to eat more milk and milk products. Other foods mentioned by one-third or more of these mothers were meat, fruits and fruit juices, sweets, and eggs. The few mothers (13.1%) who did not wish to see their children eat more food reported reasons such as the child was getting enough food for his or her needs, what the child ate was quite enough, or there was no money to buy more food for the child. No significant correlation was found between the mother's opinion about her child's eating behavior and demographic and descriptive characteristics.

Health-related characteristics of the children

Table 15 presents the illnesses the children had had during the present school year and school absences caused by those illnesses. Common cold was the most prevalent illness among the school children (79.8%). This illness is especially prevalent in the winter when it is cold during the evening and early morning, and very warm during the day. Most of those who had a cold were likely to go to school with it (51.3%), increasing the risk that other students might get it. Over half of the sample had had malaria during the present school year, and about 91% who had had malaria were absent as a result. Malaria is endemic in the Sudan in most regions. Galway et al. (1987) reported that of the 421 million inhabitants of sub-Saharan Africa, 372 million live in areas where malaria is endemic, and more than half of them in hyper-endemic areas where transmission is constant and intense.

Fever (nonspecific) ranked third among illnesses prevalent among these children. Fever could have been associated with other illnesses such as malaria or cold, but it was normally detected before other symptoms appeared. Headache not associated with fever followed fever in terms of prevalence (40.9%). Diarrhea was reported for 40.4% of the sample, with more than half of these children absent from school because of diarrhea. Galway et al.'s (1987) estimated annual diarrhea incidence rate for Africa of almost five diarrheal episodes per child denotes a formidable health risk. Assuming that each episode lasts an average of five to six days, a child born in Africa will spend one month of every year with diarrhea. However, the greatest burden of this illness falls on the youngest children. Tonsillitis was reported for one-third of the sample and caused half of those who had it to be absent from school.

Table 15. Illnesses children had had during the present school year and school absences caused by those illnesses

Illness	Children who had had illness		For children who had had the illness, those who were absent from school due to it	
	Frequency	Percent	Frequency	Percent
Common cold	158	79.8	77	48.7
Malaria	106	53.5	96	90.6
Fever (nonspecific)	85	42.9	40	47.1
Headache	81	40.9	20	24.7
Diarrhea	80	40.4	43	53.7
Tonsillitis	64	32.3	32	50.0
Toothache	51	25.8	8	15.7
Vomiting	40	20.2	27	67.5
Sore throat	14	7.1	5	35.7
Measles	4	2.0	3	75.9

Four illnesses were reported for about one-fourth or less of the sample. One-quarter of the sample had had toothache, but only 15.7% of those reporting toothache were absent from school as a result. According to the National Dental Caries Prevalence Survey of 1979-1980 in the U.S., 31.5% of children five to nine years old needed restoration of primary teeth and 3.0% of children had severe periodontal disease in need of treatment (Cross, 1985). One would expect dental problems needing attention to be even higher among this sample who had little access to dental prevention or treatment care. Agieb (1988) reported that among the health problems reported by 150 fourth grade students attending a primary school in Hai Elarab, a low socio-economic housing area in Omdurman, tonsillitis and dental caries were major problems. Vomiting was not a prevalent illness among these school-aged children, as only one-fifth of the sample

reportedly had this problem. However, about two-thirds of children who had vomiting were absent from school as a result. Vomiting may have been a symptom of other illnesses like malaria or gastro-intestinal disturbances. Sore throat was reported for only 7.1% of the sample and measles was for only 2.0%. Many of the children may have had measles before they enrolled in school. Other illnesses reported by mothers in response to an open-ended inquiry were mostly gardia (intestinal parasitic infection), vision and hearing problems, and arthritis. The rate of absentism associated with these illnesses was low.

Several statistical relationships were found between the prevalence of some illnesses among these children and descriptive characteristics. Colds were found to be somewhat more prevalent among female children than male children (x^2=4.51, df=1, p=.034) and among children who lived in the Omdurman area compared to those from Khartoum North and Khartoum (x^2=16.23, df=2, p=.000). Similarly, children in the Omdurman schools (boys' and girls' schools) had more cold episodes during the present school year than children in Khartoum North and Khartoum schools (both boys' and girls' schools) (x^2=25.82, df=5, p=.000). Similar results were found for malaria, which was more prevalent among children in Omdurman schools compared to children attending school in the other two areas (x^2=14.29, df=5, p=.013). Headache was also more prevalent among children in the Omdurman area (x^2=10.15, df=2, p=.006) and Omdurman schools (x^2=14.23, df=5, p=.014) than among children in the Khartoum North and Khartoum areas and schools. Children with vomiting were likely to be from large-sized families (p=.008).

A health score was computed to reflect the total number of the ten illnesses each child had had during the present school year. The score ranged

from 0 to 10 illnesses. Only 2.0% of the sample had had none of the ten illnesses and 13.6% had had one illness during the present school year. About 70.7% had had from 2 to 5 illnesses and the remaining 13.6% from 6 to 9 illnesses. There were no statistically significant relationship found between the health score and the descriptive characteristics.

Anthropometric characteristics of the children

The anthropometric percentiles (height-for-age, weight-for-age, and weight-for-height) of the children are presented in Table 16. About 31.4% of the children were below the 10th percentile for height-for-age, 53.6% were below the 10th percentile for weight-for-age, and 51.5% were below the 10th percentile for weight-for-height. According to standard reference, one will expect to find around 10% of a random sample of children growing at normal rates to be in this range. These results indicate that a large segment of these children were either genetically small, "stunted" (low height-for-age), "underweight" (low weight-for-age), and/or "wasted" (low weight-for-height).

About 36.9% of the sample were between the 10th and the 50th percentiles for height-for-age, 41.0% between the 10th and 50th percentiles for weight-for-age, and 40.9% between the 10th and the 50th percentile for weight-for-height. In general, around 40% of a random sample with normal growth usually falls between the 10th and 50th percentiles for the above standardized reference measurements. Thus, the findings from this study are comparable to standards for this percentile range. However, weight-for-age and weight-for-height percentiles for this sample are skewed toward the lower percentiles in this 10th to 50th range.

Table 16. Anthropometric percentiles of children (n=198)

Percentile	Height-for-age		Weight-for-age		Weight-for-height	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
≤3rd	30	15.2	45	22.7	42	21.2
>3rd, ≤5th	13	6.6	28	14.2	19	9.6
>5th, ≤10th	19	9.6	33	16.7	41	20.7
>10th, ≤20th	26	13.1	32	16.2	38	19.2
>20th, ≤30th	27	13.6	28	14.1	19	9.6
>30th, ≤40th	22	11.1	10	5.1	13	6.6
>40th, ≤50th	18	9.1	11	5.6	9	4.5
>50th, ≤60th	13	6.6	6	3.0	9	4.5
>60th, ≤70th	11	5.6	3	1.5	4	2.0
>70th, ≤80th	8	4.0	1	0.5	2	1.0
>80th, ≤90th	8	4.0	1	0.5	1	0.5
>90th, ≤95th	2	1.0	0	0.0	1	0.5
>95th, ≤97th	0	0.0	0	0.0	0	0.0
>97th	1	0.5	0	0.0	0	0.0

Few children's percentiles fell above the 50th percentile. About 20% were between the 50th and 90th percentiles for height-for-age, 5.5% in this range for weight-for-age, and 8.0% for weight-for-height. Since 40% of a random, normally-growing sample is expected to fall in this percentile range, one can conclude that children in this sample were not comparable to the standards. Only 1.0% of the children were above the 90th percentile of height-for-age, no child was in this range for weight-for-age, and only one child (0.5%) for weight-for-height. One can conclude that many children in this sample appear to have had deficits in weight and height.

Four significant relationships were found between the anthropometric percentiles of the children and the demographic and descriptive characteristics of the children and their parents. Weight-for-height percentile was positively correlated with educational achievement of the father (r=.1251, p=.044) and the

opinion of the mother about the child's food patterns (i.e., eating too much, too little, or about right) (r=.1500, p=.017). Weight-for-height percentile was also significantly related to the school in which the child was enrolled in (F=3.31, df=5, p=.007). A post-hoc t-test was done, and revealed that children in Omdurman girls school and Khartoum North girls school had significantly higher weight-for-height percentiles than children in Khartoum boys school and Khartoum North boys school. Furthermore, girls in this sample had higher mean weight-for-height percentiles than boys (p=.000). This difference may be due to the fact that in the Sudan boys are generally more active than girls because they are allowed to play outside, thus expending a lot of energy that may not be adequately provided by their diets while girls are kept at home engaged in more sedentary tasks.

Implications

Findings from the analysis of the data on food behavior patterns, health status, and anthropometric characteristics of the sample have many important implications for the nutritional status and health of the primary school children in this study. For example, approximately one-third of the families cooked in an open space outdoors or on an open veranda. This type of cooking area may subject their food to dust and flies. This contamination may increase the risk of food spoilage or gastrointestinal infections that affect children's health. The type of cooking fuel used by the majority of the subject's families (charcoal) increases the risk of both fire and burns.

The relatively low amount of money spent daily on food by some families combined with the large size of the majority of the subjects' families may have

made it difficult for some children to get the food needed for optimal health. Most families tended to purchase most of their food items from the market, and few food items were produced at home. Because of the high price of food in the capital and the high rate of inflation, this tendency to purchase most of the food may have been a drain on the financial resources of families in which the fathers had lower paying jobs, such as those who were either laborers or self-employed. Food shopping was mostly done by the children's parents. Thus, both parents should be a direct target for any nutrition education programs to help families make appropriate food choices in the market.

The majority of the children in this study ate three meals every day, and all ate breakfast at school. Eating breakfast has positive implications for children's performance at school, as documented by previous studies. Taking breakfast from home tended to result in a greater variety of foods eaten for breakfast, compared to other sources of breakfast. In contrast, most of those who ate midday snacks bought them from vendors. Vendors usually sell their snacks uncovered and in open spaces, which may subject the food to contamination from dust and flies, and thus potentially affecting children's health.

A majority of the sample who ate their midday meal with the family had a portion of the meal reserved for them. This practice may have made it more likely that the child received an adequate meal compared to those children who ate leftovers. The majority of the mothers sat with their children while their children ate the midday meal. This may have given the child emotional support and attention to motivate them to eat.

The frequency that selected foods were consumed by the children revealed the consumption of a variety of food items from the major food groups--dairy

foods, protein foods, cereal-based foods, vegetables, and fruits. Milk and milk products provided three-quarters of the sample with a daily good source of calcium and protein. However, those who did not drink milk daily probably did have another good source of calcium in their diets on a consistent basis. As expected, grain-based foods were eaten by all children. These foods provide a good source of complex carbohydrates and some B vitamins. Meats, eggs, and dried beans, also good sources of protein, were eaten by one-half to two-thirds of the sample daily or every other day, indicating a frequent source of protein for the children. Vegetables were well represented in the children's food frequency patterns. Eating a variety of vegetables helps supply children with important vitamins such as vitamin A and vitamin C. Fruits, however, were obviously infrequently eaten by the majority of the sample. Some fruits are good sources of certain vitamins that may have been low in these children's diets, such as vitamin C. Nuts and seeds, which are good sources of energy and fat, were widely consumed by the sample. Sugar also represented a good source of daily carbohydrate, thus energy, for the majority of the sample.

The major food groups were well represented in the one-day food recall of the diets of the sample. The limitation of this recall was lack of data on quantities of the foods actually eaten by the children. An opportunity for future studies is to adequately document food consumption patterns of primary school children. However, cultural food consumption patterns in the Sudan, in which mixed dishes predominate and meals are eaten from a common dish, make estimates of quantity eaten difficult.

The data on the health status of the children revealed an important implication for the health and well being of the children in this study.

Approximately three-quarters of the sample had had from two to five illnesses during the present school year. In many cases, children were absent from school due to these illnesses. Such absences most likely have an adverse effect on the children's performance at school. In addition, diseases such as cold, malaria, fever, diarrhea, vomiting, tonsillitis, and dental caries have the potential to affect children's appetites and ability to eat normally. Depressed food intake may affect the normal growth of children during the illness. With the limited money resources of low socio-economic families, health care for sick children may not have been adequate, resulting in prolonged periods of illness. Sick children typically have depressed weight gain and, if the illness is severe or prolonged, depressed growth in height. However, children can make up for this lost growth during recovery if adequate energy is eaten (called catch-up growth). The high rate of illness of this sample combined with the relatively low anthropometric percentiles suggest that both frequent illness and poor catch-up growth may have contributed to the overall poor growth of these children.

Results of the anthropometric assessment of the children revealed several trends and indicators of stature and weight as they relate to growth and nutritional status. Indicators of height-for-age revealed that many of these children either were genetically small or had "stunted" growth. Height-for-age is considered by some researchers as a good indicator of past nutritional status. Thus, one can conclude that many children in this sample had a history of poor nutritional status. Weight-for-age percentiles, which are considered by some researchers to be a good indication of present nutritional status, were also relatively low for this sample, and may be related to inadequate intake and/or illness. Additionally, weight-for-height percentiles were low for many of these

children, indicating a state of wasting. Overall, these anthropometric percentiles indicate poor growth in both height and weight and for both the present and past for these children.

THE INTERRELATIONSHIP BETWEEN NUTRITIONAL STATUS, HEALTH STATUS, AND SCHOOL PERFORMANCE

Literature Review

School enrollment and attendance

Primary schools, as formal educational settings, are the most potent socializing agents to which many individuals are exposed. As they provide the basics of education to children, they also influence psychosocial development, the acquisition and utilization of knowledge, and the economic development of individuals and society (Pollitt, 1984).

There has been a significant increase in the number of children enrolled in formal education during the last two decades. From 1970 to 1986, the number of children around the world who enrolled in the three formal levels of education (i.e., primary, intermediate, and secondary) grew from 618 million to 922 million. Growth in school enrollment in the developing countries accounted for 90% of this increase (International Conference on Education, 1989). However, the growth in student enrollment at the primary level was only 3.6%, compared to 7.0% and 9.5% increases at the secondary and tertiary levels, respectively, during 1970-1980. From 1980-1982, the growth in primary school enrollment declined to 1.3% (International Conference on Education, 1984). This decline is attributed to global economic hardship, especially in developing countries.

Enrollment rates are indicators of the effectiveness of educational service coverage. In 20 countries in Latin America and the Caribbean, statistics show that enrollment is equal to or larger than 90% of the school-aged population in only 50% of the countries (UNESCO, 1989). In the Sudan, statistics show that

35% of male and 14% of female school-age children were enrolled in school in 1960. In 1984-1986, the figure changed to 59% of males and 41% of females. In the early 1980s, the percentage of Sudanese children starting grade one who completed primary school was 61% (United Nations Children's Fund, 1987).

As illustrated by these examples, the overall picture for many developing countries shows that school enrollment is low as related to the number of children who should be enrolled. In addition, for those enrolled, there is a high chance of failure that often results in grade repetition or school dropout. The greatest problem of grade repetition is found in Africa, where in some countries 30% or more of the children (boys and girls) in primary school are defined as repeaters. In 1980, among English-speaking countries in Africa, an average of 6.1% of children in a grade had to repeat the grade, while the percentage of repeaters was 22.6% for French-speaking countries (UNESCO, 1980). Children who are either not enrolled in or drop out of school are not given the opportunity or time for formal learning. Dropping out or repeating a grade are also a reflection, to some extent, of poor performance, which also co-varies with aptitudes, abilities, and teachers' judgements regarding a child's academic progress (Pollitt, 1990).

The number of days that a child enrolled in school actually attends school is considered a strong determinant of school performance. This has been reflected by Carroll's (1963) model of school learning, in which degree of school learning is postulated to be a function of both the amount of time actually spent in learning and the time needed to learn (Carroll, 1963). In general, researchers believe that school attendance and student time on task are both significantly related to measures of student outcome (Easton and Engelhard, 1982).

Rates of student absence from school change from one year in school to another, and reasons for absenteeism may vary from child illness to child choice. Studies of the relationship between school attendance and achievement have produced positive relationships. A study was done by Easton and Englehard in 1981 to examine the relationship between elementary school absence and two measures of reading achievement in urban areas of Chicago. Records of 317 students in grades one to eight were examined. Results confirm the importance of school attendance for development of reading ability (Easton and Englehard, 1982).

A longitudinal study was conducted by Fogelman (1978) to determine the relationship between school attendance, educational attainment, and deviant school behavior at ages 7 and 15, and school attendance, reading test scores, mathematics test scores, and deviant school behavior at the age of 16. A sample of over 11,000 students in North and South England, Scotland, and Wales was followed. Findings showed a positive relationship between school attendance and educational attainment, and a negative relationship between attendance and deviant school behavior. Children with high attendance levels obtained, on average, higher academic achievement and higher scores on tests of reading comprehension and mathematics, and were less often rated by their teachers as showing deviant behavior.

School achievement

Many studies have been carried out in an attempt to identify the main determinants of children's academic achievement or performance. Some have

analyzed a variety of school-based factors, while others have examined the interaction between school-based and out-of-school factors.

Alexander and Entwistle (1988) examined factors related to children's achievement in the first two years of school. They reported that how children adapt to the routine of schooling in the first grade or two is likely to have long-term implications for their cognitive and effective development. They examined how home and school factors facilitate or hinder this process of adaptation. A sample of 825 youngsters in the first and second grades in Baltimore City Public Schools was studied. Report card grades in reading and mathematics and scores on verbal and quantitative subsets of the California Achievement Test (CAT) were used as achievement criteria. Results show that adaptation during first grade was significantly related to the availability in the home of people who encourage and help a pupil. The researchers conclude that the first school year is a period of considerable consequence for shaping subsequent achievement.

Studies conducted in developing countries show that out-of-school characteristics of students are the most important determinants of particular types of academic achievement. For example, a study was done in Indonesia with 315 fourth grade students attending government schools in rural and some urban areas of the province of Yogyakarta. Four instruments were devised to measure the environment of the home, especially the education-related aspects; the personal attitudes toward school and learning; individual characteristics; and school academic achievement. For achievement, grades in three different subject areas were used--Indonesian language, social studies, and mathematics. Of the three subject areas, Indonesian language was the most predictable, with 53% of

the variance explained by the variables measured. The variables explained only 21.4% of the variance in mathematics, and 29.8% in social studies. Results show that home background factors had the most direct impact on developing Indonesian language ability and the least impact on mathematics. The social studies fell in between (Johnstone and Jiyono, 1983).

In a review of studies of the determinants of school achievement in developing countries as measured by examination and other test scores, Simmons and Alexander (1978) found that home background and parental socioeconomic status strongly influenced student performance at primary and lower secondary grades for all subjects tested. It was concluded that, in these grades, home background generally has a stronger influence on children's school achievement than schooling variables. For example, Simmons and Sumru (1972), in a study of 124 primary students in Tunisia, found that parental socioeconomic status explained 15% of the variance in academic achievement. Similarly, the International Educational Achievement (IEA) study in Chile, India, Iran, and Thailand of reading comprehension at primary grades found that home background variables explained between 1.5% and 8.7% of the variance in test scores (Thorndike, 1973). It is significant that factors which have traditionally been regarded as essential for better education, such as higher quality teachers and expensive facilities, do not seem to significantly increase achievement at lower grade levels, even in the poorest countries (Simmons and Alexander, 1978).

The interrelationship among and between nutritional status, health status, and school performance

Fewer studies have been done to examine the effects that nutritional status and health status have on school enrollment and academic progress in comparison to studies on the social and economic determinants of schooling. Also, little attempt has been made to plan school nutrition and health interventions whose anticipated outcomes are the reduction of school wastage and improvement in academic performance, and few of the school nutrition and health interventions that have been implemented in the Third World countries have been adequately evaluated (Israel, 1990). However, nutritional and health status have the potential to significantly modify school performance because in the developing countries, particularly among the low-income segments of the population, malnutrition and infections are very prevalent. For example, protein-energy malnutrition (PEM) and certain micronutrient deficiencies are widespread. In addition, the incidence of gastrointestinal and upper respiratory tract infections is frequent, increasing the risk of malnutrition and mortality (Pollitt, 1984).

The four most prevalent types of malnutrition in the developing countries are PEM, iron deficiency, vitamin A deficiency, and iodine deficiency. Because iodine deficiency is restricted to certain geographical areas, it will not be reviewed in this section. The other three types of malnutrition will be reviewed, and all are known to affect the behavioral development and health of children (Pollitt, 1984).

Protein-energy malnutrition

Protein-energy malnutrition (PEM) is the most prevalent form of malnutrition in developing countries. It has multifactorial causes, and is often classified according to severity. Mild-to-moderate PEM is characterized mainly by growth retardation and reduction in motor activity. In severe PEM (i.e., marasmus, kwashiorkor, and marasmic-kwashiorkor) serious clinical symptoms and biochemical changes take place. Marasmus is characterized by severe weight loss (less than 60% of weight-for-age) and muscular wasting. Kwashiorkor, on the other hand, is characterized by edema, liver enlargement, dermatosis, and hair changes. Except during famine conditions, severe PEM is mainly restricted to infants and very young children (Pollitt, 1990).

Several studies conducted in developing countries suggest that even mild to moderate PEM adversely affects school performance. For example, a study was done by Agarwal et al. (1987) in Utter Pradesh, India, to determine the relationship between nutritional status and functional competence among 1,336 six to eight year olds from low-income families and attending 22 primary schools. Judged by the criterion of weight-for-age, only 15.7% of the children had normal growth. The majority of the children had either mild PEM (50.4%) or moderate PEM (31.5%). Only 2.4% had severe PEM. Using the criterion of weight-for-height, only 14% of the total sample could be considered to have normal growth. One half of all children were anemic, having levels of hemoglobin below 12 mg/dl. About 10% had levels below 10 mg/dl. Cognitive functioning and scholastic achievement were assessed by a battery of tests including social maturity, memory, Piaget's tasks, and arithmetic tests. In six of seven tests, a larger proportion of malnourished children were at a lower stage of

development than were well-nourished children, and this proportion progressively increased with increasing grades of malnutrition. Results of the social maturity, Piaget, and arithmetic tests strongly support the widely held belief that malnutrition significantly impairs intellectual and social development. It was concluded that even when malnutrition is marginal or moderate, there is a linear relationship between the severity of malnutrition and the extent of functional deficit.

Moock and Leslie (1986) conducted a study on childhood PEM and schooling in the Terai region of Nepal. Data on a sample of 350 primary school children age 5-11 years from subsistence farm households were analyzed to assess the relationship between PEM and school participation. The author reported that two-thirds of the children were underweight, or below 75% of the median for weight-for-age; two-thirds were stunted, or below 90% of the median for height-for-age; and 3% were severely wasted, or below 90% of the median for weight-for-height. School participation was determined by enrollment and grade level attainment in school. Data analysis showed that both height-for-age and weight-for-height were positively and significantly associated with the probability of a child being enrolled in school and his or her grade attainment.

In China, Jamison (1986) collected data on the height, weight, age, and grade level of over 3,000 children in five different locations to examine the relationship between PEM and grade level in school. The age range for the total sample was 7 to 15 years. The mean weight-for-age and height-for-age for the total sample were 87.27% and 93.98% of the median, respectively. Students in rural areas were consistently further behind in school than students in urban

centers. However, in all locations children with low height-for-age and weight-for-age were consistently further behind in grade level than those with average or high growth indices.

From the above mentioned studies, one can conclude that children with a history of undernutrition do not perform as well in formal schooling or achieve as high a grade level as their well-nourished peers.

Iron deficiency

Second to protein energy malnutrition (PEM), iron deficiency is the most prevalent nutritional deficiency in developing countries. Iron deficiency is defined as a state of depletion of body iron stores (Pollitt, 1990). During iron deficiency the hemoglobin concentration usually is below normal levels for an individual. Decrease in hemoglobin concentrations can be attributed to a deficiency of not only iron, but also nutrients such as folic acid, vitamin B_{12}, pyridoxine (vitamin B_6), and protein. These nutrients are required for the process of hemoglobin formation (hemopoiesis). Moreover, in many parts of the world iron deficiency anemia often coexists with PEM and other micronutrient deficiencies. Insufficient transport of oxygen by blood to cover the body's needs is a symptom of iron deficiency anemia. Iron deficiency exerts a debilitating effect on the physical work capacity of primary school children due to a decrease in attention span and ability to concentrate (Pollitt, 1990).

The focus of most research on iron deficiency anemia has been on the cognitive function of infants and pre-school children and on the physical work capacity of adults. The effect of iron deficiency and anemia on the behavior and achievement of school-age children in formal educational settings has been

given little attention. However, over the last decade there has been an increasing number of experimental studies with iron-deficient children in which the effect of iron treatment has been investigated. For instance, in a study done in an economically deprived rural area in central Java, Indonesia, 78 iron-deficient anemic and 41 non-anemic children were examined to measure the effect of iron supplementation on measures of school performance. Subjects were randomly assigned to either an iron or placebo group, and hematological and behavioral measurements were obtained immediately before and after the iron and placebo treatments. Iron treatment for a three month period resulted in substantive increase in mean hemoglobin, hematocrit, and transferrin saturation among the iron deficient anemic children, and this change was associated with significant changes in the school achievement test scores of these children. Findings from this study indicate that iron supplementation among iron deficient anemic children may benefit the learning process, as measured by school achievement test scores (Soemantri et al., 1985).

Agarwal et al. (1987) reported findings of a study done in India to assess whether anemia and mental function among school age children were correlated. The anemic children were classified into three groups according to severity of the anemia (measured by hemoglobin concentration levels). Iron treatment was given for an entire school year. Piaget tasks for assessment of level of cognitive development and a series of arithmetic and achievement tests were used. It was found that iron status was positively related to performance on a school achievement test (arithmetic), and changes in performance were positively correlated with changes in iron status following iron treatment.

Pollitt (1990) reviewed eight studies conducted in Indonesia, the Philippines, Thailand, India, and Israel on the relationship of iron status to cognitive performance. It was found that in comparison to non-anemic children, anemic children performed significantly worse in reading, mathematics, vocabulary, and problem-solving tests. Furthermore, he concluded that even mild cases of anemia tended to be related to shortened attention span, irritability, fatigue, and decreased ability to concentrate.

In summary, primary school children in developing countries are considered a vulnerable group for iron deficiency since they need iron for growth and tissue maintenance but may be consuming little dietary iron. Symptoms usually associated with iron deficiency anemia are fatigue or tiredness, apathy or lethargy, and breathlessness (Parker, 1989). These symptoms usually increase with increased severity of the anemia. Primary school children who are anemic may not be able to function well at school because they are tired, apathetic, less responsive to environmental stimuli, disinterested, and less motivated to learn. If anemia is prevalent, large numbers of children may not adequately learn the skills they need to later optimally function in the adult work force.

Vitamin A deficiency

Vitamin A deficiency is prevalent among populations in which children are weaned to a diet that contains small amounts of animal foods, green leafy and yellow vegetables, and fruits. The deficiency normally reduces the capacity of the organism to resist infection, causes disorders in metabolism, and results in eye lesions in the cornea that can progressively worsen until blindness occurs (Pollitt, 1984). In humans, particularly children, vitamin A deficiency often

affects the eyes both externally by disturbing the epithilia of the cornea and conjuctiva and internally by lowering the sensitivity of the retina to light; the former condition is called xerophthalmia and the later night blindness. In severe vitamin A deficiency, blindness can result from ulceration of the cornea, called keratomalacia, in which softening and necrosis of the corneal stroma occurs (Mohamed, 1989). Vitamin A deficiency is often accomplished by PEM and is linked with increased frequency of infection and defective immunological defense mechanisms.

Within the education sector, vitamin A deficiency and its consequences of visual impairment have not received enough attention. Young children with severe vitamin A deficiency normally die, and those who become blind are unable to enter school. Educators need to gather sufficient data to point out the problem of millions of school-age children who are blind due to vitamin A deficiency, raising the awareness of those who are in charge of the education sector to both educational alternatives available for blind children as well as prevention of this serious problem (Pollitt, 1990).

Worldwide, vitamin A deficiency is a significant public health problem in many countries. For example, the number of preschool children demonstrated to have active corneal lesions is over 100 out of every 1,000 in Bangladesh, over 80 out of 1,000 in Indonesia, and over 5 out of 1,000 in Malawi (Pollitt, 1990). Most of the prevalence studies have been restricted to pre-schoolers because among older children adequate criteria for prevalence estimates have not been established. WHO (1985) also estimated that about 500,000 new cases of eye damage per year occur in Asia due to vitamin A deficiency. Estimates suggest that those who become totally blind represent approximately 25% of the total

number of cases of xerophthalmia that survive. About 50 to 69% become partially blind, and 15 to 25% fully recover (World Health Organization, 1985). In most developing countries, special education facilities are not available, and most children with visual impairments are placed within the traditional educational sector.

Sudan was categorized by the WHO as a country where vitamin A deficiency, xerophthalmia, and nutritional blindness are significant public health problems in certain location of the country (Pollitt, 1990). In 1977 in the Red Sea area in Eastern Sudan a survey on vitamin A deficiency was conducted. It was found that 3.9% of primary school children had Bitots spots and 4.2% had night blindness (Mohamed, 1989). In a study done during 1987-1988, 213 children 12 to 60 months old with cases of kwashiorkor (74), marasmus (65), and marasmic-kwashiorkor (40) were examined at Khartoum Teaching Hospital for signs of vitamin A deficiency. Results showed 4.2% had night blindness, 16.4% had conjuctival xerosis, 5.6% had Bitots spots, and 2.8% had corneal ulceration. The majority had serum retinol which was very low (88.3%), especially among those who have diarrhea and respiratory infection (Mohamed, 1989).

Methodology

Data collection

The school record of each subject in the study was examined by the researcher to obtain information on the grade in which the child was currently enrolled, the age at which the child was first enrolled at school, the number of years the child had spent repeating a school grade/grades, the number of days the child had been absent from school during the present school year, and how many

days he/she had been absent because of being sick. In addition, the child's most recent cumulative grades in math and language and class rank were recorded.

Data analysis

Frequencies and percentages were calculated for all variables. The days the child had been absent and the days of absence due to sickness were converted into percentages by dividing these numbers by the total number of school days in the present school year up to the days of data collection. Each child's classroom rank was also converted into a percentile rank using the total number of students in his/her classroom. Accordingly, students were grouped into four quartile groups. Spearman's correlation coefficients, t-tests, and chi-square values were computed to examine the interrelationships between descriptive characteristics and school performance variables. Relationships between selected variables were also investigated using analysis of variance and post-hoc t-tests.

Results and Discussion

Descriptive information concerning school enrollment, attendance, and achievement is presented in Table 17. Over half of the sample were first enrolled after age 7 (53.5%) while approximately 30% of the sample were enrolled prior to age 7. Parents usually send their children to school when they are about 7 years old. A new policy of the Ministry of Education in the Sudan is to set the age of enrollment at six and to have eight years of primary school starting the school year 1992-1993. Only 4.5% of the subjects had repeated a grade at school. A relatively low rate of repetition results in low wastage in the educational process.

Table 17. Descriptive information concerning school enrollment, attendance, and achievement (n=198)

Variable	Frequency	Percent
Age of first enrollment		
Prior to age 7	59	29.8
Age 7	53	16.7
After age 7	106	53.5
Number of years child repeated a grade		
0	189	95.5
1	9	4.5
Percentage of days absent from school in present school year		
0	52	26.3
1-2 percent	74	37.4
3-4 percent	36	18.2
5 percent or more	36	18.1
Percent of days absent from school for documented medical reasons in present school year		
0	65	32.8
1-2 percent	72	36.4
3-4 percent	34	17.2
5 percent or more	27	13.6
Achievement math score (potential range 0-60)		
51-60	82	41.4
41-50	51	25.8
31-40	31	15.6
21-30	14	7.6
11-20	10	5.1
0-10	9	4.5

Table 17. Continued

Variable	Frequency	Percent
Achievement language score (potential range 0-60)		
51-60	114	57.6
41-50	41	20.7
31-40	19	9.6
21-30	15	7.6
11-20	6	3.0
0-10	3	1.5
Class rank in quartiles		
First quartile (top 25% of class)	96	48.5
Second quartile	46	23.2
Third quartile	29	14.7
Fourth quartile (bottom 25% of class)	26	13.1

A little over one-quarter of the sample had not been absent from school during the present school year, about 37% had been absent for 1-2% of the days, 18.2% for 3-4% of the school days, and a similar percentage for 5% or more of the school days. Similar percentages of absenteeism due to documented medical reasons were recorded. Over two-thirds of the subjects were reported to have been absent due to a documented medical reason. Thus, it appears that most of these children's school absences were due to illness.

The potential range for the math and language scores in the first three grades of primary school was 0-60. About 41% of the math scores and 58% of the language scores were above 50, and approximately 29% of the math scores and 21% of the language scores were between 41 and 50. Only 13.5% of of the math

scores and 10.5% of the language scores were failing scores (i.e., below the cut off point of 30). Therefore, the overall achievement of these children as reflected by these grades was very good. This high achievement is further reflected in the relatively high percentage of the sample in the top quartile of their class. Approximately half of the sample was grouped in the first quartile (top 25% of their class) and only 13.1% was in the fourth quartile (bottom 25% of their class).

The total number of children in each of the 18 classes participating in this study ranged from 53 to 102. These class sizes are generally considered too big to be managed by one teacher, as was the norm in these schools. Furthermore, Simmons and Alexander (1978) report that teacher-student interactions are difficult with large size classes, and hence affect the performance of the majority of students in the class.

Several statistical inter-relationships were investigated between in-school variables and the demographic characteristics. The age that the child first enrolled in school was positively correlated with the child's current grade ($r=.1689$, $p=.009$). Children who were in higher grades at the time of the study tended to have been enrolled at an older age than children who were in lower grades. The age that the child was first enrolled in school was negatively correlated with mother's education ($r=-.1996$, $p=.002$) and with weight-for-age percentile ($r=-.1251$, $p=.040$). Mothers with lower educational attainment tended to enroll their children in school at an older age, and those who were enrolled at an older age tended to have lower weight-for-age percentiles than those who were enrolled at a younger age.

The percentage of days the child had been absent from school was significantly related to the school ($F=2.861$, $df=5, 192$, $p=.016$) and area ($F=3.682$,

df=2, 195, p=.027). Children of Arkawit boys school in Khartoum and Khartoum area had a higher rate of absenteeism than children in other schools and other areas. Child absenteeism was also significantly related to father's occupation (F=2.792, df=3, 176, p=.042). Children whose fathers were laborers or self-employed had been absent a greater percentage of days during the present school year than children whose fathers were government officers or owned small businesses. Absenteeism was negatively correlated with mother's educational achievement (r=-.2300, p=.000) and with the child's weight-for-height percentile (r=-.1567, p=.014). Children of mothers with lower educational achievement tended to have been absent from school more than children whose mothers had higher educational achievement. Furthermore, children with lower weight-for-height percentiles tended to have been absent from school more than those with higher weight-for-height percentiles. In contrast, absenteeism was positively correlated with height-for-age percentile (r=.1436, p=.022) and the health score computed in the previous chapter (r=.3127, p=.000). The more illnesses the child had had, the more likely he/she was to have a high rate of absenteeism. The reason for the positive (but low) correlation of height-for-age with absenteeism is not known.

The percentage of days the child had been absent from school because he/she was sick was positively correlated with the percentage of total days the child had been absent (r=.911, p=.000), the health score (r=.4016, p=.000), and the height-for-age percentile (r=.1308, p=.033). The first two correlations again illustrate that most absences were due to illness. In contrast, the percentage of days the child had been absent because of sickness was negatively correlated with mother's schooling (r=-.1530, p=.016) and the weight-for-height percentile

(r=-.1537, p=.015). Children absent from school due to illness were more likely to have mothers with lower educational achievement and to have lower weight-for-height percentiles.

The children's achievement in math as represented by their math scores was significantly related to their grade (F=8.046, df=2, 195, p=.000), their school (F=7.222, df=5, 192, p=.000) and their area (F=8.856, df=2, 195, p=.000). First grade children scored better in math than second grade, who scored better than the third grade children. Furthermore, children in Elhag Yousif girls and boys school (i.e., Khartoum North area) scored better in math than children in Ombada and Arkawit schools and/or in Omdurman and Khartoum areas. In general, girls scored better in math than boys (p=.032). Mother's educational attainment may have had an influence on their children's scores in math. Children of mothers with lower educational achievement tended to have lower math scores (r=.1877, p=.004). Math scores were negatively correlated with the percentage of days the child had been absent from school (r=-.5487, p=.000) and absent due to illness (r=-.4588, p=.000), the health score (r=-.1297, p=.034), and height-for-age percentile (r=-.1352, p=.029). In other words, children with a higher rate of absenteeism, with or without sickness, and who had had more types of illnesses tended to score lower in math than children with lower absenteeism rates and fewer types of illnesses. Fogelman (1978) reported that children who are frequently absent from school show poor attainment and adjustment to school.

On the other hand, language scores were positively correlated with math scores (r=.6010, p=.000), mother's educational achievement (r=.2080, p=.002), and weight-for-height percentile (r=.1790, p=.006). Children with higher language

scores tended to also have higher math scores, mothers with higher educational achievement, and higher weight-for-height percentiles than children with lower language scores. Girls also tended to score better in language than boys (p=.002). Similar to math scores, language scores were negatively correlated with percentage of days absent (r=-.5951, p=.000), percentage of days absent due to sickness (r=-.5241, p=.000), the health score (r=-.2160, p=.001), and the height-for-age percentile (r=-.1516, p=.017).

Class rank as a third indicator of the children's educational achievement or performance yielded findings similar to those discussed above. Students with higher language scores, math scores, and mother's educational achievement tended to have a better class rank (r=-.8131, p=.000; r=-.7373, p=.000; and r=-.2653, p=.000, respectively). On the other hand, children with higher rates of absenteeism, higher absenteeism due to sickness, and a higher health score tended to fall in the lower ranks of their class (r=.6671, p=.000; r=.5747, p=.000; and r=.2260, p=.002, respectively). A higher height-for-age percentile was associated with a lower class rank (r=.1254, p=.039).

Implications

Analysis of the data obtained from school records revealed that the home background and health conditions among these school-age children were interrelated with educational outcomes. For example, it appears that most absenteeism was due to illness, and absenteeism was negatively related to children's performance at school. Children with higher rates of absenteeism tended to score lower in math and language and tended to fall in the bottom 50% of their class. Children whose fathers had lower paying jobs (i.e., laborers or self-

employed) tended to have higher absenteeism rates than children whose fathers were government officers or owned small businesses. This implies that socioeconomic background, represented by father's earning capacity, may have had an impact on educational outcomes. Children with more frequent absenteeism also tended to have weight-for-height percentiles which were lower than children with less frequent absenteeism, possibly reflecting the negative impact of their frequent illnesses on growth.

Mother's educational achievement tended to be positively associated with all determinants of school performance. Unfortunately, approximately two-thirds of mothers of the sample had either no education or only primary school education, which may have made it difficult for them to relate to their children's progress in school and influence their children's learning behavior. Programs to improve the educational outcomes of school-age children should take into consideration improvement of the mother's educational abilities, and assure continuous education for mothers and women, in general.

Height-for-age percentiles were statistically related to several indicators of educational achievement, and this variable's association was opposite to that which would have been predicted. For example, higher height-for-age percentiles were related to lower math scores, language scores, and class rank. The reason for these curious statistical relationships are not known and are possiblely related to variables not investigated in this study.

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to investigate the interrelationships among and between indicators of nutritional status, school performance, and living environment of first, second, and third grade Sudanese primary school children living in low socioeconomic housing areas in the state of Khartoum. The sample of 198 boys and girls ages 6 to 10 years was randomly selected from six primary schools in three low socioeconomic housing areas in Khartoum (one boys' school and one girls' school in each area). At each school, 11 children from each of the first three grades were selected for the study. An interview was conducted with the mothers or female guardians of the participants in their homes. In addition, each student's height and weight were measured by the researcher at school, and selected items from his/her school records were recorded (i.e., attendance, grades for math and language, and class rank).

The interview form was composed of four main sections. First, demographic data were obtained. Part two contained questions that revealed information on the housing and environmental conditions of the subjects. Part three dealt with the food behavior patterns and health status. The final section was used to record data about the children's school attendance and performance and the anthropometric measurements (weight and height) of the subjects.

Demographic data revealed that the fathers of the subjects had varied educational backgrounds and occupations, with about 60% having less than a high school education. The majority of the subjects' mothers did not work outside the home, and 97% had less than a high school education.

Most subjects lived in large households of from 8 to 12 people. The majority of the families owned their homes and had lived in them for over 10 years. Generally, the families' living area was small; an average of three to six rooms was the norm. The availability of tap water piped inside the home was widespread, except in the Omdurman area. The use of pit latrines was the most common method of human waste disposal in the three areas of study. The garbage disposal system appeared inadequate, with only about 60% of the families having access to garbage removal services. Most families had electricity, television, radios, and refrigerators, and families with more goods and services were more likely to be headed by fathers who were government officers or owned small businesses. On the other hand, families headed by fathers who were laborers or self-employed were more likely to raise goats and chickens. These animals were usually kept in enclosed pens, and the families commonly used the animals or their products for food. Few families raised kitchen gardens.

The kitchen facilities of the families varied from separate rooms either inside or separate from inside the house to simply cooking in a space outdoors. However, the use of hazardous types of cooking fuel was widespread. Most families purchased the majority of their food items from the market, which may have placed a burden on these low-income families' incomes and limited their purchasing power.

The 198 children tended to eat three meals and one or more snacks daily. Food frequency data indicated that most of these children ate bread, milk and/or milk products, meat, and nuts and seeds every day. Foods that were least frequently eaten by the children were eggs, grassa, kissera, porrige, sweets like cookies, fresh fruit or fruit juice, and rice. Both sexes were similar in their food

behavior and consumption patterns except for the consumption of milk and milk products and fruits and fruit juices, which males tended to consume more frequently than females, while females tended to consume green vegetables more frequently than males. A previous day's food intake recall revealed that the children were most likely to have tea (with or without milk), sugar, and bread as a morning snack before going to school. The breakfast meal at school was usually a wheat bread sandwich of cooked dried beans with vegetable oil and/or salad. A midday snack was most likely to be eaten at home, and composed of whatever was leftover of the families' breakfast. The main afternoon meal was usually a meat stew with vegetables, salad, and bread, and/or kissera. Evening snacks were consumed less often by most of the children, and the evening meal typically resembled the breakfast meal.

An indication of health status was obtained by a recall of how many of ten common illnesses each child had had during the present school year, and the rate of school absenteeism due to these illnesses. The majority of the subjects had had from two to five illnesses during the past year. The most common illnesses were common cold, malaria, fever (non-specific), headache, and diarrhea, and the illnesses that had most commonly caused school absences were malaria, vomiting, diarrhea, common cold, tonsillitis, and fever.

Anthropometric measurements of height and weight were obtained for all subjects. Percentiles for height-for-age, weight-for-age, and weight-for-height were determined using WHO reference percentiles. Overall, the children in this sample were shorter and lighter compared to the children in the WHO reference sample. For example, 21.7% were below the 5th percentile for height-for-age,

while 36.9% and 30.8% were below the same level for weight-for-age and weight-for-height, respectively. Girls had significantly higher weight-for-height percentiles than boys.

The school records of the sample revealed that the majority of the children had first enrolled in school after age seven and ranked in the top half of their class on academic performance scores. Absenteeism rates averaging 2-4% of the present year's school days were documented for the majority of the sample. Absenteeism was due mainly to sickness. As the mother's educational achievement increased, the child's grades in math and language tended to increase, and the children of more highly educated mothers tended to have lower rates of absenteeism. Lower rates of absenteeism were also associated with higher weight-for-height percentiles, fewer illnesses, and higher language scores. Girls in this sample had significantly higher scores in math and language than boys, and children in lower grades tended to have higher math and language scores than children in higher grades.

Conclusions

The data generated in this study are valuable not only due to the findings presented in previous chapters, but also because the study was the first to focus on several health-related indicators of young school children in the Sudan. The instrument developed can be administered by the researcher and other investigators in similar studies. This research is the first to investigate the interrelationships among nutritional status, health status, housing and living environment, food behavior, anthropometric characteristics, and school performance of primary school children in the Sudan. Previous research on

Sudanese students has been limited to investigations of either the health status of primary school children or the health and academic achievement of university students.

However, this study has several limitations which restrict its generalizability. First, this study was conducted with primary school children living in low socioeconomic areas in the state of Khartoum and should not be generalized to other populations. Furthermore, many other variables not investigated in this study are likely to influence the major factors studied. These variables include previous history of childhood illness, birth weight and history of growth during infancy and early childhood, exposure to a home environment that fosters learning, in-school variables such as availability of skilled teachers, sufficient books, and a favorable teacher to student ratio, and long-term quantity and quality of food intake. In addition, indirect indicators of school achievement, nutritional status, and food intake were used in this study. Direct indicators of these variables should be developed and/or used in future investigations, necessitating the input of substantial funding, time, and skilled researchers. Despite these limitations, several conclusions can be drawn.

The findings of this study coupled with the results of other studies suggest that housing, environmental conditions, and family characteristics are strong indirect out-of-school determinants of students' health and achievement. For example, the mother's educational background was significantly associated with the child's age of school enrollment, school attendance, and school performance. These findings suggest that the child's success in school is at least partially set by the family's characteristics and the learning environment it provides. Therefore, a country's development plans should take into consideration the importance of

women's education and training, which are essential tools for social and economic development. A functional literacy program coupled with primary education and training should be designed and executed for women in low socioeconomic areas. Additional research can help identify the educational and training needs of mothers as well as more fully delineate the impact of the mother's educational backgrounds on their children's progress in school.

The interaction among and between housing, environmental conditions, and family characteristics perhaps also contributed to the high rate of illness among this sample of children. Illness was the major cause of school absence among these children, and higher rates of absenteeism were significantly related to poor school performance, as documented by lower grades and class rank. The high prevalence of illness may also have implications for physical development, since first through third grade children are in critical periods of growth. Frequent illness coupled with poor food intake can lead to faltering growth. In fact, anthropometric data indicated that both past and present growth were poor for the majority of these boys and girls. The major issue that educational planners need to address are that a large group of malnourished or unhealthy children is going to act as a major constraint on efforts to increase enrollment; reduce absenteeism, dropout, and grade repetition rates; and improve academic performance. Therefore, strategies to overcome problems in the educational sector must be coupled with programs to improve health and nutritional status. Educational improvements can be fostered by utilizing schools, teachers, parents, and the community in the delivery of nutrition, health and education services.

Finally, primary school education is very important for the society as it provides a major part of the education of children, influences their cognition,

social behavior, formation of learning skills, acceptance of modernization, and economic productivity. For a nation to develop, it is important to have healthy growing children who will be the future tools of productivity.

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APPENDIX A

RESEARCH INSTRUMENT

Date:_____ Area:_____

Time:_____ Interviewer:_____

Child's name:_____ Subject number: ___ ___ ___

INTERVIEW SCHEDULE

Conduct the interview with the mother or female guardian of the 7 to 9 year old child who is the focus of the interview.

DEMOGRAPHIC DATA

1. What is the child's birth date? Month_____/Day_____/Year_____
   (If the birth date is not known, record the child's age to the nearest year here: _____)

2. What is the child's sex? _____Male _____Female

3. Who lives in this household? (Record the number of persons in each category.)

number		number	
_____	Grandparents of child	_____	Sisters of child
_____	Mother of child	_____	Brothers of child
_____	Father of child	_____	Other relatives of child
_____	Father's other wives	_____	Others

4. What are the ages of the child's brothers and sisters (Ashiga)? (record ages to the nearest year; for infants, record as less than 1 year)

#1	_____ years	#5	_____ years
#2	_____ years	#6	_____ years
#3	_____ years	#7	_____ years
#4	_____ years	#8	_____ years

5. How many children younger than 7 years old live in this household? _____ (number)

6. How many children ages 7 and above and still in school live in this household? _____ (number)

7. What is the father's tribe?_____

8. Is the father able to read (eg., a newspaper)? _____Yes _____No

9. Is the father able to write (eg., a letter)? _____Yes _____No

10. What is the highest level of school that the father completed? (check one).

_____Do not know
_____None
_____Khalwa religious education
_____Primary school
_____Junior secondary school
_____High secondary school
_____University or post university

11. What is the father's current occupation or occupations?

_____

(Write in the specific name and description of each occupation.)

12. How long each day does the father work outside the home? (check one)

_____ All day
_____ At least half of the day
_____Less than half of the day
_____Does not work outside home

13. Is the mother able to read (eg., a newspaper)? _____Yes _____No

14. Is the mother able to write (eg., a letter)? _____Yes _____No

15. What is the highest level of education that the mother completed? (check one)

_____None
_____Khalwa religious education
_____Primary school
_____Junior secondary school
_____High secondary school
_____University or post-university

16. What is the mother's current occupation or occupations?

_____

(Write in specific name and description of each occupation.)

17. How long each day does the mother work outside the home? (check one)

_____ All day
_____ At least half of the day
_____Less than half of the day
_____Does not work outside home

18. How long has this family lived in the capitol? (check one)

_____Less than 5 years
_____5-10 years
_____More than 10 years

19. *(Ask only if answer to question above is 10 years or less)* Where was this family's home area before coming to the capitol? (check one)

_____Northern Sudan
_____Southern Sudan
_____Central Sudan
_____Eastern Sudan
_____Western Sudan
_____Do not know

HOUSING AND ENVIRONMENTAL CONDITIONS

20. How long has this family lived in this house? (check one)

_____Less than 1 year
_____1-3 years
_____4-6 years
_____7-9 years
_____More than 9 years

21. Is this house owned or rented by this family or provided by the government? (check one)

_____Owned by family
_____Rented by family
_____Provided by government
_____Other (specify):_____

22. How many rooms are in this house? [Count bedrooms, kitchen (if it is a separate room or separate building), bathroom (if it is a separate room inside). Do not count hallways, verandas, or open cooking areas.] _____ (number)

23. Where does this household obtain its drinking water? (check all that apply)

_____Tap inside household
_____Public tap
_____Well
_____Vendor
_____River

24. Does this household store drinking water? _____Yes _____No

If yes, where? (check all that apply)

_____Barrel, covered
_____Metal, plastic, or clay container, covered
_____Barrel, uncovered
_____Metal, plastic, or clay container, uncovered
_____Other (specify type, covered or uncovered)_____

25. What type of toilet is used by household members? (check all that apply)

_____Flush toilet inside house
_____Bucket inside house
_____Bore hole inside house
_____Pit latrine outside house (built structure surrounding it)
_____Hole in ground outside house (no built structure surrounding it)
_____Other (specify): _____

26. How does this household dispose of garbage? (check all that apply)

_____Picked up by garbage cart
_____Throwing on outside garbage pile
_____Burying in ground
_____Burning
_____Other (specify):_____

27. Does this household have these items or services?

Yes	No	
_____	_____	Electricity
_____	_____	Refrigerator
_____	_____	Radio
_____	_____	Television
_____	_____	Car
_____	_____	Sewing machine

28. Does this household raise goats?

_____Yes (number:_____) _____No

If yes

Is milk from these goats used for the household? Yes____ No____

Is meat from these goats used for the household? Yes____ No____

If yes, how are goats kept in the house? (check one)

_____Kept in enclosed pen in the house

_____Allowed to wander in the house

29. Does this household raise chickens?

_____Yes (number:_____) _____No

If yes

Are eggs from these chickens used for this household? Yes____ No____

Is meat from these chickens used for this household? Yes____ No____

If yes, how are chickens kept in the house? (check one)

_____Kept in enclosed pen in the house

_____Allowed to wander in the house

30. Does this household raise a kitchen garden?

_____Yes _____No

If yes

Are vegetables from the garden used for this household? Yes____ No____

FOOD BEHAVIOR PATTERNS

31. What type of cooking area does this household use? (check all that apply)

_____Kitchen as room inside house

_____Kitchen built separate from inside house

_____Open space outdoors

_____Open veranda

_____Other (specify):_____

_____

32. What type of fuel does this household use for cooking? (check all that apply)

_____Electricity
_____Charcoal
_____Wood
_____Gas
_____Kerosene
_____Other (specify):_____

33. About how much money does this household spend per day on food? (check one)

_____100 pounds or less
_____101 to 200 pounds
_____201 to 300 pounds
_____301 to 400 pounds
_____401 to 500 pounds
_____More than 500 pounds

34. Are these foods usually produced at home, bought at the market, or bought from a vendor? (check all that apply)

	Home	Market	Vendor
Milk			
Yogurt			
Butter			
Wheat or bread			
Sorgum or kissera			
Millet			
Lentils and beans			
Chicken			
Meat			
Fruits			
Vegetables			

35. Who usually shops for food at the market? (check all that apply)

_____Self
_____Husband
_____Son
_____Other (specify):_____

36. How many meals does (child's name) usually eat each day?
_____ (number)

37. Does (child's name) usually eat breakfast while at school?
_____Yes _____No

If yes, where does the child usually get his/her breakfast food? (check all that apply)
_____Takes from home _____Buys from food shops
_____Buys from vendor _____Other (specify):_____

38. Does (child's name) usually eat snacks while at school?
_____Yes _____No

If yes, where does the child usually get his/her food for snacks? (check all that apply)
_____Takes from home _____Buys from food shops
_____Buys from vendor _____Other (specify):_____

39. When (child's name) comes home from school, does he/she eat the midday meal then or wait and eat later with the family? (check one)
_____Eats then _____Eats later with family

40. *(Ask if answer to question above is eats later with family)* Do you usually save a portion of the midday meal food for (child's name) and the other children, or are they fed the leftovers after the adults have eaten? (check one)
_____Portion saved _____Leftovers

41. Do you usually sit with (child's name) as he/she eats his/her midday meal?
_____Yes, always _____Yes, sometimes _____No

42. How often does (child's name) eat these foods -- every day, about every other day, at least once per week, at least once per month, or seldom or never? (check one blank beside each food)

Food	Every day	About every other day	At least once per week	At least once per month	Seldom or never
Milk, cheese, or yogurt					
Bread					
Grassa, kissera, or porridge (sorghum or millet)					
Rice					
Meat like goat, beef, fish, or chicken					
Eggs					
Dried beans					
Green vegetables like molokhya, regla, and okra					
Yellow vegetables like sweet potatoes, squash, pumpkin, and carrots					
Other vegetables like potatoes					
Fresh fruit or fruit juice like watermelon, oranges, and bananas					
Nuts and seeds					
Sweets like cookies, soft drinks, candy, sugar cane, and dates					

43. Did (child's name) eat these meals and snacks yesterday?

Name of meal/snack	Yes or no	If yes, foods eaten and drunk for meal/snack
Morning snack	___Yes ___No	
Breakfast meal	___Yes ___No	
Midday snack	___Yes ___No	
Afternoon main meal	___Yes ___No	
Evening snack	___Yes ___No	
Evening meal	___Yes ___No	

44. Do you think that (child's name) eats too much food, about the right amount of food, or too little food for his/her age? (check one)

_____Too much _____Too little

_____About right _____Do not know

45. Would you like to see (child's name) eat more food than he/she is eating now?

_____Yes _____No

If yes, what foods would you like to see (child's name) eat more of?

_____

If no, why not?

_____

HEALTH STATUS

46.

During the present school year, did (child's name) have any of these illnesses?			If yes, did this illness cause the child to be absent from school?	
	Yes	No	Yes	No
Diarrhea				
Vomiting				
Common cold				
Tonsillitis				
Fever (nonspecific)				
Measles				
Sore throat				
Malaria				
Headache				
Toothache				

47. What other illnesses did (child's name) have during the present school year? (List names of illnesses)

Name of illness	Did this illness cause the child to be absent from school?	
	Yes	No
1._____	___	___
2._____	___	___
3._____	___	___

48. Anthropometric characteristics:

Height (measure to nearest 1/2 cm): ___ ___ ___ . ___

Weight (measure to nearest 1/2 kg): ___ ___ . ___

INFORMATION FROM CHILD'S SCHOOL RECORDS

Date:_____ Subject number: ___ ___ ___

Child's name:_____

What is the child's birth date? Month_____/Day_____/Year_____

School:_____

1. Grade child is currently enrolled in (or, if school is not in session, grade child most recently completed):

   _____Grade 1 _____Grade 2 _____Grade 3

2. At what age was this child first enrolled in school:

   ____Prior to age 7 _____Age 7 _____After age 7

3. How many years has this child spent repeating a school grade/grades?

   _____None _____2 years of repeat
   _____1 year of repeat _____3 years of repeat

4. a. How many days was this child absent from school during this present school year? _____ out of _____ school days this year

   b. If child was absent from school during this present school year, how many days was he/she absent for documented medical reasons?_____

5. For most recent school achievement record:

   A. What was the child's grade in math? _____ _____ _____

   B. What was the child's grade in language? _____ _____ _____

   C. What was the child's class rank? _____out of _____

APPENDIX B

MODIFIED INFORMED CONSENT FORM

IOWA STATE UNIVERSITY 143
OF SCIENCE AND TECHNOLOGY

College of Family and Consumer Sciences
Department of Family and Consumer
Sciences Education and Studies
219 MacKay Hall
Ames, Iowa 50011-1120
515 294-6444
FAX 515 294-4493

Date _____

Dear Parents,

My name is Sidiga Washi, graduate student in Family and Consumer Sciences Education at Iowa State University, USA. I am working on a research project determining the interrelationships between nutritional status, living environment, and school performance of primary school children 7-9 years old. The sample I plan to focus on is children 7-9 years old in the first three grades of primary school. Participation in this project will involve interviewing the mother or guardian of selected children to answer some background information about her child's nutrition and living status. It should take about one hour to be interviewed.

Your participation is completely voluntary. Information about you or your child will be treated confidentially.

In addition to the interview, I will be weighing and measuring the height of each child at home or at school during a regular school day. Also, I will be recording the child's grades in math, language, and the child's class rank during the last academic year from his or her records at school. A permission slip to include your child in the measuring and to record his or her performance is attached on the following page. Please sign, date, and return it to the interviewer.

If you do not wish to participate or let your child participate, or if you or your child may want to decline at any point of the study, you may simply decline to sign or be interviewed, or you can inform the researcher or your child's school administrators. I appreciate your support and interest in this project.

Thank you.

Sincerely,

Sidiga Washi

I give permission to the researcher to weigh and measure for height my child _____ either at home or at school during the next five days. I understand that this should take approximately 10 minutes. In addition, I give permission for the researcher to record from my child's school record his or her latest grade in math and language and class rank. I understand that this information will be treated confidentially.

_____
Parent's Name

_____
Date